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ABSTRACT

Part 1 of this paper reviews major research findings on the relationship of teacher characteristics to student achievement. Of the 16 teacher variables analyzed, those identified as important to student performance are teacher certification, ability and achievement, experience, inservice training, expectations for students, and methods. Policy recommendations include the development and improvement of teacher training programs in developing countries, accompanied by thorough research into the demographic, structural, and cultural context for each program and focusing on the development of teacher knowledge and ability in specific subject areas. The authors also recommend further research on the impact on learning of the unique relationships between teacher and student as well as the threshold effects of teacher competence variables. Part 2 of the paper reviews an empirical study of the effect of teacher training and teacher competence on student science achievement in the countries of Chile and India. Verbal IQ shows the strongest effect on student achievement, followed by teaching methods, teacher training and home background. (Author/WD)

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TEACHER TRAINING AND STUDENT ACHIEVEMENT IN LESS DEVELOPED COUNTRIES

This paper reviews major research findings pertaining to the relationship of teacher characteristics, including the level of educational attainment and pedagogical training, with student performance in developing countries. The authors report that they found this relationship to be complex and mixed, some of the variables showing positive relationship, while others showed negative or no correlation. They conclude that a larger number of especially the more carefully designed and executed studies revealed a positive relationship between teacher training and student achievement in LDCs.

This conclusion is given further support in Section II of the paper which consists of a re-analysis of data collected in India and Chile by the International Association for the Evaluation of Educational Achievement (IEA).

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PREFACE

Teacher training is a major area for Bank financing in view of the fact that provision of qualified teachers has been and continues to be a major constraint faced by LDCs. However, in recent years educators have expressed doubt whether increased investment in teacher training will necessarily result in better education. In brief reference to this issue the 1974 Education Sector Paper stated (pages 36-7):

> "The findings of recent research tend to challenge some of the assumptions concerning the relationships between .. level of training of teachers, and student achievement ... A study in a Latin American country indicates that students do almost as well when studying under normal school-trained teachers as they do when they are taught by university graduates. The cost-saving implications are significant. These results should be interpreted with care to avoid hasty generalizations ... they indicate, however, that the scope for improvement in the cost-effective use of teachers may be greater than was traditionally assumed."

In an effort to shed further light on this issue the Education Department asked Professor Torsten Husén of the Institute for the Study of International Problems in Education at the University of Stockholm to study the state of the art in measuring the relationship between teacher training and student achievement. The study was conceived basically as a survey of the existing literature and research reports to examine how strongly teacher training is linked to student achievement.

As the authors indicate, the studies included in the literature review employ a variety of research designs and methodological strategies so that the conclusions must be regarded as tentative. Further, in view of the complex and mixed relationships that the study found between teacher characteristics and student achievement, the authors urge caution not to make simplistic interpretations and conclusions.

Notwithstanding the above constraints, the study nevertheless makes an important contribution to the current discussion in the Bank and merits wide circulation within and outside the Bank. The major conclusions and policy recommendations of the study are summarized on pages 55-70. In their conclusions the authors point out that, although the interrelationship between the variables are mixed, a clear pattern can be seen: the bulk of the studies show significant positive effects, a smaller number show no effects, and few show negative effects. According to the authors, "by far the most impressive evidence focused on variables linked with teacher qualifications and credentials. Contrary to the arguments presented elsewhere, the evidence here suggests that trained teachers do make a difference". (pages 61-2)

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Introduction

Recent survey research, notably the Coleman (1966) study on equality of educational opportunity, in the United States, the study commissioned by the Plowden Commission in England on 11-year-olds (HMSO, 1967), and the 20-country study conducted by the International Association for the Evaluation of Educational Achievement (IEA) (Walker, 1975) has raised doubts as to whether teacher qualifications, and particularly teacher training, make any difference. Such a proposition runs counter to common sense and has inspired an extensive methodological discussion. Needless to say, attempts to identify and assess the relative importance of certain factors in the pedagogic milieu that account for student competence is extremely difficult. Factors that determine outcomes, both cognitive and affective, are almost inextracably intertwined and interact in a complicated way in bringing about learning. Nevertheless, there is an almost boundless body of research on how outcomes of schooling are related to various "input" factors.

Sophisticated techniques, of which some have been applied in the research presented in the second part of this report, have been developed to measure the direct and indirect effects of specific factors in the pedagogic milieu.

Most of these studies have been conducted in the United States and Europe. The difficulties that beset the measurement of teacher classroom behavior has led most researchers to use formal credentials, such as length of formal schooling, training certificates and length of service, as proxies of teacher competence. As can be seen from the literature review, there is a large number of American and European studies on how teacher behavior and teacher competence are related to student achievement. Since relatively few surveys in which student achievement have been used as a criterion, have been conducted in developing countries, the literature search has located only some 32 studies from some 20 developing countries, where attempts have been made to identify and measure the impact of teacher qualifications.

The present report consists of two parts. Part I presents the outcomes of the literature review in which all relevant studies have been considered both conceptually and methodologically. Dr. Lawrence J. Saha has been responsible for the literature search and has authored this part of the report. Part II presents a re-analysis of data collected in India and Chile by IEA. By applying new techniques of multivariate analysis, attempts are made to assess not only the direct and indirect effects of teacher competence, as measured by formal credentials, but also the potential effects of improved teacher education. Dr. Richard Noonan has been in charge of the research behind this part and has written it. A technical Appendix presents details about the methods employed.

Both parts of the report lead to the conclusion that teacher education makes a difference both in developed and in developing countries, particularly in the latter.

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SUMMARY

The purpose of this report is to critically assess all available research in less developed countries (LDCs) which investigate teacher training variables and student achievement. The systematic search through bibliographic and institutional resources located 32 legitimate and valid empirical studies of student achievement which met the necessary criteria. Three types of studies are reviewed: (1) simple correlation studies using non-experimental data; (2) multivariate studies using non-experimental data; and (3) experimental studies.

This report begins by briefly describing the current discussions of teacher training effects in industrialized western societies, and the general tendency to question the importance of school and teacher variables in student outcomes. This is followed by a description of the strategy used in the assessment of these studies, in particular the classification and selection of the 16 teacher-related variables which are the central focus of this report.

The main body of the report, Section III, analyzes the findings of the studies relevant for each of the teacher variables. The results of these analyses, plus the recommendations derived from them, are presented in Section IV.

The general assessment of the 32 studies within the context of 16 teacher variables concludes that trained teachers do make a difference in student achievement in LDCs.

In particular, it seems clear that teacher qualifications, experience, amount of education, and knowledge are positively related to student achievement.

Secondly, certain attitudinal variables emerge as highly important, especially positive expectations of students, which it seems can override negative student self-images. On the other hand, there is only moderate support for the notion that teachers can improve student achievement by assigning more homework or spending more time preparing lessons.

Finally, demographic and social variables, such as sex, age, and socioeconomic status, appear to have mixed effects, but the emergent patterns suggest that males are more successful for science and mathematics teaching, and older teachers are more successful with secondary school students. There is only slight support for the notion that teachers from higher status backgrounds are more successful than those from lower status origins.

The report concludes with policy recommendations and suggestions for future research. With respect to policy, it is suggested that teacher training be upgraded in LDCs, with a focus on improving teacher knowledge and positive teacher attitudes towards students. Furthermore, some allocation of teachers needs to be made on the basis of social and demographic characteristics in order to maximize teacher success. This can be done only after the relevant demograhic, social and cultural characteristics of a country have been well investigated and understood.

Further implications of this reoprt for teacher training, especially with respect to "threshold effects", teaching styles, and alternate methods and strategies for costs and efficiency, are briefly considered.

Future research should attempt to find out how and under what circumstances teachers in LDCs are most effective. Studies using an experimental, multi-variate design should be preferred, and attention should be directed to interactions between teacher variables. Replications conducted in different types of societies, different subject areas, non-cognitive outcomes, and different grade levels are strongly advised, as it cannot be assumed that education operates in the same manner in all societies. Only then will the teacher-learning process in LDCs be better understood.

PART I: LITERATURE REVIEW

INTRODUCTION

A. Background of the Project

The impetus for the literature research into the relationship between teacher training and student performance in less developed countries (LDCs) is found in the World Bank's Education Sector Working Paper (1974). The Bank's current policy regarding the potential resources of teacher upgrading for increased efficiency in education is based on the conviction that one of the major handicaps of educational systems in LDCs has been the shortage of good teachers at all levels, both with respect to supply and adequate training. Furthermore, attempts to upgrade teachers have generally not been successful. The problem is particularly important since, as the Bank's statement points out, "... teacher costs, which range from 75% to 95%, are by far the most important single factor determining education expenditures". (p. 36)

The Bank's sector paper also recognizes that the presumed relationship between teacher training and student achievement must be regarded with caution, since "the findings of recent research tend to challenge some of the assumptions concerning the relationships between class size, level of training of teachers, and student achievement" (p. 36). Thus the efficiency of teacher training programs to improve educational outcomes in LDCs may be problematic.

Because of the uncertainty of some current research findings, the Bank has reopened discussion about financing teacher training programs, the reason being that "it does not help". In order to provide a more firm basis for policy decisions in this area, the Bank has commissioned the Institute for International Education, University of Stockholm, to provide a position paper which will include, along with further analyses of relevant IEA and Botswana data, a thorough critical survey "on the current knowledge about the correlation between teacher training, the instruction given by teachers and the students' learning".

This literature review, will then critically examine all legitimate research, experimental as well as survey, which investigate all aspects of teacher characteristics and behavior and student achievement in less developed countries. Relevant studies from developed countries will be discussed where appropriate.

B. The Literature Review: Proposed Outline

The literature report, as indicated in the table of contents, is organized into four parts. The first part will briefly summarize the current state of knowledge about teacher effects in developed societies. The problematic nature of this research will be discussed and the implications for developing countries will be made clear in order to show that findings in developed countries may not be the same as in the less developed ones.

Part II consists of a description of the procedures which will be followed in the assessment of the research literature. In particular, the sixteen teacher variables which have been isolated in the literature are described.

The main section of this report, and the lengthiest, is Part III. The findings of the 32 studies are described and discussed within the context of each teacher variable. The intention here is that by consulting the discussion of a teacher variable, e.g. teacher experience, one can find the evidence from the relevant studies critically discussed and assessed.

Part IV will include a summary of the findings as they relate to teacher training upgrading programs. Policy implications from these general conclusions are then presented.

Systematic summary tables of the studies considered in Part III will be found in the annexes. Furthermore, some conceptual and methodological issues which may bring about an underestimation of teacher effects in LDCs will be briefly reviewed. Attention is directed to some generally held assumptions about the educational context of children in LDCs, specifically the impact of schooling on cognitive development, the cross-cultural sharing on cognitive processes, and the actual experience of schooling itself. The methodological summary will include a discussion of the limitations of survey research for assessing teacher effects, and the assumptions underlying multiple regression and variance explained strategies.

An appendix describing the search strategy for the relevant achievement studies and a complete bibliography conclude the report.

I. TEACHER TRAINING AND ACHIEVEMENT IN EDUCATIONAL RESEARCH

A. Developed Countries

The current debate about the determinants of student achievement, and specifically the contributing effect of teacher variables, has its origins primarily in the findings of the Coleman Report (1966), and later, the work of Jencks et al., (1972). Both of these studies concluded that school service effects were minimal in the explanation of student achievement. On the one hand, the EEOS study did isolate one teacher variable of some significance, i.e. verbal ability (possibly a proxy for a number of related skills and qualities). However, Jencks and his colleagues were less optimistic, as is apparent in their frequently-cited conclusion:

> "Our research suggests, however, that the characteristics of a school's output depends largely on a single input, namely the characteristics of the entering children. Everything else - the school budget, its policies, the characteristics of the teachers - is either secondary or completely irrelevant." (p. 256)

These two studies have tended to dominate current educational thinking (at least in the United States) and have cast doubt in the minds of many policy-makers about the usefulness of increased investment in the educational establishment, both in developed and less developed countries. However the findings of Coleman and Jencks have not been entirely consistent with the cumulative body of research in this area.

To date there have been numerous attempts to systematically review the achievement literature in order to critically assess, synthesize, and organize the information currently available, but with mixed success. The results of four of these reviews are briefly summarized here.

1. Lavin's (1965) The Prediction of Academic Performance, sponsored by the Russell Sage Foundation, preceded the Coleman Report by one year. This survey covered almost 300 studies published between 1953 and 1961, and was divided into six topical areas: (1) the concept of academic performance and problems of measurement, (2) the problem of predicting academic performance, (3) intelligence factors as predictors, (4) personality factors as predictors, (5) sociological determinants of performance, and (6) directions for future research.

The investigation of studies which included teacher variables were restricted to those dealing with the congruence of student and teacher role expectations and the relationship between teacher behavior and achievement. After reviewing thirteen studies on role expectations, Lavin concluded that "the degree of congruence in student-teacher values, attitudes and expectations is directly related to the academic performance of the student". Of the four studies of teacher behavior effects he was more cautious and concluded that "student behavior is more independent of the acts of the teacher on the high school level than on the elementary level" (p. 144).

2. The Coleman Report was directly responsible for a second review of the literature which focused specifically on the effects of school and teacher variables on achievement. Guthrie's (1970) "A Survey of School Effectiveness Studies" (in Do Teachers Make a Difference?) examined 19 studies conducted between 1956 and 1969. Without taking into account the relative importance of teacher effects, Guthrie concluded that the evidence unambiguously and consistently supported the existence of significant relationships between some teacher variables and student achievement. In summary, his findings were as follows:

(i) Fifteen studies reported significant positive relationships between student performance and teacher verbal ability, amount and type of academic preparation, degree level, job satisfaction, and employment status.

(ii) In those studies which included them, access variables were found to have a consistently positive effect on achievement, namely: student-staff ratios, classroom size, school or school district size, and length of school year.

(iii) Building and other resources were also found to have positive effects on achievement, such as age of building, extent of physical facilities, expenditures per pupil, and the teacher salary levels.

3. A more extensive literature review was that commissioned by the IEA to provide a background for future IEA reports. In Teaching Behaviors and Student Achievement, Rosenshine (1971) analyzed "approximately 51" studies covering seven aspects of teacher behavior and a number of antecedent and demographic teacher characteristics. 1/

Understandably the results of this detailed and far-ranging investigation are difficult to synthesize, and only the most important conclusions need be mentioned here. Briefly, Rosenshine found that in about half the studies, certain aspects of teacher approval behavior were consistently and significantly related to achievement, namely teacher use of criticism, use of student ideas, and teacher warmth. Studies of teacher cognitive behavior produced mixed results, although there was consistent support for the importance of achievement-oriented behavior, organization, clarity, and structuring. There were no consistent relationships with the variables difficulty of instruction and use of questions in the classroom.

There were consistent positive relationships for teacher enthusiasm and frequency of teacher-student interaction, as well as general student and teacher ratings of teacher behavior. The only "time-related" variable which emerged as consistently significant was student opportunity to learn, used in the IEA mathematics study.

1/ Most of these studies were conducted and reported in the United States while only a few were from England or Australia.

It should be noted that these variables deal with aspects of teacher behavior, and the literature is not consistent as to whether these behaviors can be "taught" or are irrevocably determined by background factors (Morrison and McIntyre, 1969). Nevertheless one can hypothesize that given the necessary knowledge about the determinants of teacher behavior, any desired behavior can be instilled through appropriate teacher training programs. However, regarding the antecedent and demographic variables, which in many respects include the more traditional teacher characteristics, and those perhaps more immediately relevant to policy manipulation, Rosenshine reached the following conclusion:

> "Consistent and significant results were <u>not</u> found in the areas of teacher experience, amount of teacher training, teacher knowledge, and teacher general attitude." (p. 219)

4. Without doubt, the most comprehensive recent attempt to critically assess and synthesize research on student achievement has been that by Averch et al. (1972), <u>How Effective is Schooling</u>? prepared by the Rand Corporation for the President's Commission on School Finance. The reviewers selected approximately 100 important and methodologically valid studies for analysis in order to "assess the current state of knowledge regarding the determinants of educational effectiveness". They subjected these studies to rigorous examination regarding internal validity and inter-study consistency. A broad range of studies within five "approaches" were included: (1) the input-output approach, (2) the process approach, (3) the organizational approach, (4) the evaluation of broad educational interventions, and (5) the experiential approach (the so-called "reform" literature).

The overall conclusions of this review are summarized in five propositions: <u>2/</u>

1. "Research has not identified a variant of the existing system that is consistently related to students' educational outcomes;

2. Research suggests that the larger the school system, the less likely it is to display innovation, responsiveness and adaptation and the more likely it is to depend upon exogenous shocks to the system;

3. Research tentatively suggests that improvements in student outcomes, cognitive and non-cognitive, may require sweeping changes in the organization, structure, and conduct of educational experience;

<u>2/</u> Averch et al. actually reach six conclusions, one of which is not included here since it does not relate directly to the subject of this report. The underlined passages above are mine.

4. Increasing expenditures on traditional educational practices is not likely to improve educational outcomes substantially;

5. There seem to be opportunities for significant redirections and in some cases reductions in educational expenditures without deterioration in educational outcomes". (pp. 154-158)

The generally ambiguous and null conclusions of these four surveys of the achievement literature continue to receive support in much of current empirical research in developed countries. The findings of Jencks and Brown (1975) in their reanalysis of achievement outcomes for 98 Project Talent schools is a recent example. Using nine measures of achievement outcomes and eight school characteristics (all aggregated at the school level), Jencks and Brown conclude that "... high school characteristics such as social composition, per pupil expenditure, teacher training, teacher experience, and class size have no consistent impact on cognitive growth between the ninth and twelfth grades". (p. 320)

What do these various reviews of the research literature tell us about the importance of teacher characteristics on student achievement in developed countries? On the one hand, taken at face value, the weight of cumulative evidence casts serious doubt that teachers, given their present level of training, explain much of the difference in student performance. There are others, however, who argue that the results of these studies are problematic on methodological or other grounds, and that the real importance of teacher effects have yet to be adequately investigated. Nevertheless, in terms of policy relevance for further improving the efficiency of educational systems, there is a growing consensus of scepticism which is best reflected in the following summary observation of education production studies:

> "Research to date has found little or nothing in school resources that consistently and unambiguously makes a difference to student outcomes, such as achievement. Once widely-held beliefs about the overriding importance of school and teacher quality have been called into question, if not refuted". (Nollen, 1975:74)

B. Less Developed Countries

It would be presumptuous to uncritically extrapolate the findings from developed countries to the developing ones. However, to date there has been relatively little research on the determinants of achievement in LDCs. Thus, in order to have some guidelines for policy decisions, the Bank commissioned its own survey of available literature, which is probably the only one thus far attempted. In The Determinants of School Achievement: The Education Production Function, Alexander and Simmons (1975) located 17 EPF studies, nine of which provided the basis for their assessment. Using a stringent criterion for accepting studies for their review (OLS multiple regression), the authors directed attention specifically to those factors which could be manipulated by policy decisions.

Drawing on data collected from nine developing countries (St. Lucia, Kenya, Tunisia, Chile, Puerto Rico, Malaysia, Iran, India, and Thailand), Alexander and Simmons conclude that the determinants of achievement in LDCs do not differ markedly from those found in developed countries. Their findings concerning the relative importance of home background or parential socio-economic status are mixed. They find that student background effects are consistently strong at the primary and early secondary levels, but become less important in upper secondary grades.

They argue that there seems to be general consistency among the findings that home background or parental socio-economic status exercises a strong effect on student performance at primary and lower secondary grades in all academic subjects tested, though the variance explained appears to be somewhat less than comparable findings in the developed countries.

Although there can be little question that schools in LDCs promote learning, and that inefficient schools might be preferable to no schools (see the discussion in the next section of this report), Alexander and Simmons appear doubtful about the possibility of improving learning rates by educational policy changes "along traditional lines, such as providing more and/or better teachers and facilities" (p. 52). Their conclusions regarding the importance of teacher variables are particularly relevant here, given the scope of the present report.

1. "Teacher certification and academic qualifications are not important at primary and lower secondary grades. However they appear to be important at upper secondary grades..."

2. "The percentage of teachers on permanent contract (tenure) is not important at primary and lower secondary grades."

3. "Teacher experience does have a positive influence on performance in primary and lower secondary grades. However, it is not important in the upper secondary grades."

4. "Teacher sex has a changing impact on performance. Male teachers positively influence male students grades 5 to 8, but have a negative influence on male and female students at the upper secondary level."

The authors further conclude that while expenditure variables are not important predictors of student achievement, teacher motivation, textbook availability, and the amount of homework performed by students do emerge as significant. Thus the policy recommendations regarding teacher training are limited to improved screening in teacher recruitment and training teachers how to assign homework (Alexander and Simmons, 1975:55).

Thus, even from this preliminary perspective, it appears that the support for the importance of teacher variables as determinants of student achievement in LDCs is far from impressive. Clearly, a focused assessment of all relevant and valid empirical studies needs to be carried out before any reliable policy inferences for teacher training can be drawn. Furthermore, it should be kept in mind that school achievement research in LDCs is based upon a number of assumptions and follows methodological procedures which may underestimate the true importance of teacher effects. A discussion of some of these contextual and methodological issues as related to LDCs is found in Appendix A.

Attention is now directed to the strategies used for selecting and classifying the studies relevant for this report, and the specific variables related to the analysis of teacher effects.

II. TEACHER CHARACTERISTICS AND ACHIEVEMENT IN DEVELOPING COUNTRIES: DESCRIPTION OF CLASSIFICATION PROCEDURES

At the time of writing this report, 32 separately authored studies relating teacher variables and student achievement in LDCs had been located and analyzed. 3/ However, as will become clear, many of these studies actually consist of a number of replications, for example separate analyses of both primary and secondary students, in different countries such as Chile and India, and using different performance measures such as science and reading. Thus the IEA report on science achievement by Comber and Keeves (1973) includes studies of three school population groups (10-years-old, 14-years-old, and final year of secondary schooling) in four developing countries (Chile, India, Iran, and Thailand) 4/. If these replications are considered as separate studies (which they are), each contributing to the cumulation of knowledge about teachers and student performance, the total number of independent studies represented in this report is 64. Studies which investigated student achievement but without specific measures of teacher related variables are not included in this report. 5/

A. General Classfication of Studies

In order to facilitate later discussion of these studies, it is first useful to describe them in a general systematic manner. With respect to inclusion criteria, the primary requirement for a study to be considered in this review was that it includes a measure, either direct or by proxy, of teacher related variables. Thus if an author used "school quality" as an analytical variable, but took this as an indicator of "teacher quality" (as in Silvey, 1972) the study was included. On the other hand if a reference to any teacher characteristic was not explicitly made (as in Studstill, 1976), the study was not included.

3/ No assumption is made that all existing studies have been located. However, given the search strategy (of Appendix B) it is unlikely that any major study relevant to this topic remains unknown.

4/ For this and other IEA reports, each country was not necessarily studied for each population or each performance criterion. Thus for science achievement, there was no study of Pop. I (10 yr) students in Thailand.

5/ Of particular importance are a number of studies which investigated the effects of background variables, without including school or teacher variables. Indirectly these studies are useful in that they lend indirect positive support or negative support for the findings in developed countries. Such studies are Chopra, 1967; Epstein, 1974; Hornik, et al., 1973; Leacock, 1972; Lynch, 1975; Weightman and Rihani, 1967; Currie, 1974; Drysdale, 1972; Garcia, et al., 1974; Simmons 1970/1972; 1970; Studstill, 1976; Ayabe, 1973.

As can be seen from Annex Table I, the studies can be classified according to two dimensions. The first differentiates between those which utilize multivariate techniqus that is, one or more control variables in the analysis of the relationship between the independent and dependent variables, and bivariate techniques, which consider only the direct relationship between two variables. The second dimension differentiates between studies based on survey research designs and experimental research designs.

As apparent in Annex Table I, there is considerable imbalance in the frequency with which studies of these various types have been conducted. By far the most common type of study relating teacher characteristics and student performance in LDCs has been the survey, using multivariate analytic strategies, with 20 studies falling into this cell. This is followed by seven studies which are survey researches using bivariate techniques, three of which incorporate an experimental design and multivariate strategies, and finally two which are experimental and bivariate.

From a methodological point of view, the most important studies should be those which follow experimental multivariate strategies since the effects of particular teacher characteristics on student performance are identifiable and measurable in a reliable and valid manner. The next most valuable set of studies are the survey multivariate-type, although they suffer the weakness of the cross-sectional design. Of less value in contributing to our knowledge of teacher effects are the bivariate studies, since they do not take into account multi-collinearity as discussed in Appendix A. It should be noted, however, that other things being equal, the experimental studies are more useful than the survey studies.

The above comments are essential in assessing the respective merits of the various studies reviewed in this report, as more weight will be given to those studies which are most sophisticated and reliable. Furthermore the unequal frequency of studies of the various types, and in particular the low number of potentially the most valuable type of study may highlight the need for the planning and design of future studies of social factors of differential student achievement in LDCs.

Annex Table II shows the various countries covered by the studies in this report. Overall, 19 LDCs are represented, seven in Africa, five from Latin America, and seven from the Middle East and South East Asia. The only area completely unrepresented is the South Pacific, including Papua-New Guinea.

B. Description of Teacher Variables

As is always the case in attempts to synthesize large numbers of researchers according to some criteria, judgment is always called for in the identification and classification process according to which the criteria have been met. This was certainly the case in preparing this report. While on the surface, the mandate to survey the literature on teacher effects in LDCs may seem clear and unambiguous, this was not the case. Teacher variables are many, and variations in conceptualization and measurement in these studies required

decisions as to the important groupings and classification dimensions represented. In the end, after a careful reading of previous literature reviews of teacher variables, and the 32 LDCs studies, four groupings of teacher variables were constructed, each with a more specific subset of relevant teacher characteristics. Fifteen teacher variables, plus the combination of school-teacher variables into a block, unique to the IEA studies, were further identified. All of these variables are policy-relevant and can be manipulated through teacher recruitment and training programs. In this resport, the teacher variables can be described as follows:

1. Demographic and Background Variables

The variables in this group pertain to factors which are probably best controlled through recruitment and selection to the teaching profession. They are in the order found in Annex Table III as follows: sex, age, socio-economic background, and the extent to which English was spoken in the home.

2. Teacher Qualifications and Training

This group of variables pertain specifically to aspects of teacher certification or levels of competence as determined by "officially recognized" credentials. Included here are teacher educational attainment (number of years schooling or level attained), educational qualifications (teacher diploma, certificate, etc.), cognitive ability, teaching experience, salary, and finally participation in teacher upgrading programs.

3. Teacher Behavior and Attitudes

The variables identified within this group are attitudes towards students (expectations of students), teaching methods (technology, TV, radio, programmed teaching, etc.), teacher absenteeism and punctuality, attitudes toward job and career, and finally teacher behavior (homework assignments and amount of lesson preparation).

4. School-Teacher Block Variables

This section includes IEA studies where the regression analysis strategy first grouped variables into homogenous "Blocks" corresponding to the major factors presumed to affect student achievement. Each block was then entered into the equation, with step-wise procedures determining the order to entry of individual variables within blocks. Thus, for example, in Comber and Keeves (1973), Block 1 consisted of student home background variables and entered the equation first, while school type was included in Block 2 and entered the equation second. For most IEA volumes, school condition variables and teacher variables were incorporated into Block 3, and entered the equation after Block 2. Although the individual teacher variables which were included in Block 3 varied within IEA from study

to study, the value of these data lie in the relative importance of school-teacher variables for achievement vis-a-vis other Blocks, and for different LDCs, student populations, and achievement subjects. Annex Table III shows the variables which were considered in each of the thirty-two studies discussed in this report. The table will serve as an overview and guide to the following discussion of research evidence for the importance (or lack of it) for each teacher variable.

III. TEACHER CHARACTERISTICS AND STUDENT ACHIEVEMENT IN LESS DEVELOPED COUNTRIES: ANALYSIS OF THE RESEARCH

A. Demographic and Background Factors

It is not difficult to develop an argument showing the importance of background variables of teachers with respect to student achievement. For example, one could argue that females are more effective in the primary grades and males in secondary grades. Likewise one might hypothesize that older teachers are more or less successful depending on whether the relevant characteristics are experience and stability on the one hand or enthusiasm and close identity with students on the other.

There is sound reason to suspect that demographic characteristics such as these might be important in LDCs. For example, in societies where age and sex roles are clearly defined, the relationships between students and teacher could be seriously affected.

The same holds true for the SES background of the teacher. R. Dave for example, has argued, that at least in India, good teachers are partly the result of family background - that teaching "runs in the family", and for whatever reason - an environment of curiosity, or a family tradition of teaching - people from these backgrounds turn out to be more effective teachers. 6/

In each of these examples there are policy implications with respect to intervention programs designed to maximize the teaching process in LDCs.

Turning to the studies included in this report, four teacher variables have received attention: sex, age, SES background, and frequency of spoken English in the teacher's childhoood home.

The first observation which can be made about this set of variables is how little attention they have received in research on student achievement in LDCs. For example only a third of the studies in this report have taken teacher demographic and background characteristics into account. On the one hand, as already suggested, the effects of teacher sex, age, and in particular socio-economic origin, may be crucial in understanding the mode (quality) of interaction between teacher and student in the classroom context. On the other hand, one could argue that demographic and background variables are so highly intercorrelated with more specific teacher competence characteristics, which are more readily interpretable and manipulatable, that they are less important in empirical research.

6/ By personal communication, IIEP, Paris, March 18, 1977.

1. Sex of Teacher

It was pointed out earlier by Getzels and Jackson (1963), that some personal-social characteristics were different for men and women teachers at both primary and secondary levels, with men being generally more business-like and emotionally stable but less friendly and responsible. Morrison and McIntyre (1969) have further noted that the sex of teachers has a "pervasive" ifluence on "perceptions of pupils, the aspirations and attitudes of pupils, and the teacher's degree of involvement in the job of teaching". (p. 51)

In the IEA twelve-country study of mathematics achievement, while there were clear differences between countries, the overall pattern of zero-order correlations for each of the four student populations indicates that male teachers are slightly more successful than females (Husén, 1967:270-271). With respect to LDCs, Alexander and Simmons (1975) concluded from their review that male teachers were more effective for the performance of male students for grades 5 to 8, but less effective in general at later secondary levels.

The evidence from IEA clearly documents wide disparities between countries, grade levels, and subject areas in the proportions of males and females in the teaching corps. The data presented in Comber and Keeves (1973), for example, show that for 10-years-olds (Population I) the proportion of male science teachers for fifteen countries varied from a low of 8% (Hungary) to a high of 91% (India). For 14-year-olds (Population II) the range for seventeen countries was 17% (Iran) to again 91% (India), with a similar pattern for terminal second-year students. Since these variations cut across the LDCs in the sample, it is highly likely that cultural differences regarding sex roles and the teaching profession are present, and should be kept in mind when interpreting research results.

As indicated in Annex Table III, seven of the 32 studies included information and analyses of teacher sex and its effects on student performance. However, taking into consideration separate analyses by country, school level, and subject area (i.e. the achievement criterion), there are, in fact, 26 studies reported by the seven sets of authors (see Annex Table IV.1).

Each of these studies has been carefully examined to record (and in some cases determine) the direction and strength of the association between sex of teacher and achievement. For all studies, a positive relationship (+) indicates that female teachers are associated with higher student performance, whereas a negative relationship (-) indicates the opposite. For the Carnoy, Klees and Ryan studies, the researchers own assessments regarding the significance of the relationships were accepted. For the IEA zero-order relationships, t-tests were performed to test statistical significance taking into account the variations in sample size (see Peaker, 1975, for a full account of sampling for schools and students). 7/

7/ This same procedure holds for all zero-order coefficients reported from the IEA studies.

As indicated in Annex Table V, nine of the relationships were positive, favoring female teachers, twelve were negative, favoring male teachers, while six recorded no relationship at all. Thus the overall evidence seems to slightly support the notion that male teachers are more effective than female teachers. However this very general observation requires considerable caution, as the specific patterns are more complex.

Carnoy (1971), for example, found in his analysis of 1967 school data in Puerto Rico for grades 3, 6, 9 and 12 that the proportion of male teachers in a school was slightly related to higher Spanish and general ability examination performance in the third grade, but negatively (and more strongly) related for grades 6, 9 and 12.

Ryan (1974), on the other hand, studied 797 second grade students in three governorships in Iran and found that the female teachers were significantly more successful than the male ($r = .28$). However, stratifying by sex, Ryan found that female teachers were effective mainly in larger and urban schools, and moreover, because of multicollinearity with other bakcground, school and teacher variables, teacher sex was not included in the multiple regression equations.

Finally, Klees (1972) investigated the effects of television and other determinants on mathematics and language achievement in Mexican secondary schools. Sampling two groups of schools in four areas, those using Telesecundaria instructional TV and traditional instruction ($N = 58$ classes, 1,236 students and 23 classes and 1,101 students (respectively). Klees found that while there were no differences in language results, male teachers were more effective with respect to student mathematics achievement.

Given these variations in teacher sex effects suggested by the foregoing three studies (i.e. grade level, region, and subject area), what do the IEA results indicate? The pattern of coefficients is hardly consistent, as an inspection of Annex Table IV clearly indicates. In general there is more support for greater success among male than female teachers, particularly in pupil science achievement. This is clearly the case for Chile, though less clear for India and Iran. On the other hand, four of the six analyses of performance in English and French as a foreign language show female teachers to be more successful, and in three of four analyses in these subjects from the Chile samples.

Thus it would appear from the IEA data at least, that males are more successful than females in science teaching, while females are more successful in languages, and perhaps related subjects. There do not seem to be any consistent patterns for the various school level populations or the countries of India, Iran and Thailand.

As mentioned earlier, the intercorrelation between sex and other relevant teacher and personality variables requires more rigorous multivariate analysis before firm conclusions about the effectiveness of male or female teachers can be drawn; unfortunately the evidence available from these studies does not permit high level analyses. Nevertheless it would be premature to dismiss sex as an important teacher characteristic in maximizing student achievement in LDCs, and moreover the emergent patterns from these data suggest the possible effectiveness of selective recruitment by sex, and more emphasis could be given to matching male and female teachers with students, regions, student age groups, and subject areas, at least in those countries where cultural norms would permit.

2. Age of Teacher

Teacher age correlates with many relevant teacher characteristics, for example experience, seniority, salary and career stability and commitment. Getzels and Jackson (1963) point out that older teachers tend to manifest classroom behaviors distinct from younger teachers, in that the former are less systematic and businesslike and more "permissive". Finally, insofar as cultures differ with respect to age-specific roles and statuses, teacher age is likely to have an independent effect on pupil learning and performance, though perhaps more in some societies than others.

Comber and Keeves (1973) document differences between countries in age distributions of the science teaching staff. For 10-year-old pupils (Population I) the mean age across fifteen countries ranged from a low of 26.3 years for Thailand to a high of 43 years for Italy. Likewise the proportion of teachers under 27 years ranged from 61% for Thailand to 6% for Italy. Similar ranges, though on a slightly older threshold, prevailed for the 14-year-old and terminal year secondary school students. Insofar as these range variations cut across the four LDCs in the IEA sample, one would expect age to exercise some influence on student performance.

Unfortunately teacher age effects were not reported in the IEA reports, although there were four other studies which did include teacher age in their analyses.

Klees (1974) failed to find any relationship between age of teacher and achievement in his Mexican Telesecundaria study. This finding is consistent with that reported by Fuller and Chantavanich (1976) in their national study of 987 teachers and 23,555 third grade pupils in Thailand. The zero-order correlations of teacher age with the combined achievement score on arithmetic and Thai language at the beginning and end of third grade were -.038 and -.036 respectively. As a result of these low correlations, teacher age was dropped in subsequent analyses of the determinants of achievement. 8/

8/ It should be noted that for this Thailand study, step-wise regression procedures resulted in about equal proportions of variance being attributable to student SES, and school and teacher effects.

On the other hand, Farrell and Schiefelbein (1975) found in Chile that teacher age did have an effect on student performance. The authors studied a national sample of 8th grade classes stratified by location with a final N = 3530. Achievement was measured by scores on a national 8th grade test, which consisted of 100 questions, half verbal and half mathematics. The Beta coefficient between achievement and teacher age was .067, and was significant at the .01 level. The authors conclude that age is a proxy for experience, and is important as a determinant of student performance.

Husén (1977) also found significant age effects on mathematics and reading achievement for Standard 7 pupils in Botswana. Like Farrell and Schiefelbein, Husen notes the interrelationship between age and experience, and attributes the effects of the former to the latter. He further raises the question as to whether experienced teachers are assigned to the better schools, both in terms of students and resources, certainly a potential focus for further analysis.

How can we explain the difference between the results of the Farrell and Schiefelbein, and Husen studies, and that of the Fuller and Chantavanich study? All appear to be statistically sound and valid, and well designed and executed. One possible explanation (excluding measurement and distribution differences) might be that the Thailand sample consisted of 3rd grade students while the Chile and Botswana samples were 7th and 8th graders. It could be that age effects become more pronounced in the higher grades when perhaps experience and stability become more important. Unfortunately the only secondary level study is that reported by Klees, which lends little insight to effects of age on secondary schooling, since it concerns teachers of Telesecundaria schools in Mexico and in a strict sense is not comparable.

Whatever the ultimate explanation for effects of teacher age on student performance, it appears fairly certain from the evidence cited here, that at least toward the end of primary and in secondary school, older teachers are more successful than younger ones.

3. Teacher SES Background

Like the previous variable, teacher socioeconomic background also seems to have been little researched in LDC countries. Yet it is useful to note that in developed countries one of the major criticisms directed at schools by the reformers is the middle-class orientations of teachers and their inability to communicate with, or understand children from other status backgrounds. It would appear that at least potentially, this problem could be even more pronounced in some LDCs where the cultural differences between teachers and students might be even more pronounced.

Only three of the 32 studies investigated the status background of teachers: Farrell and Schiefelbein's (1974) study of approximately 3530 grade 8 Chilean students, Ryana's (1974) study of 797 2nd grade Iran pupils and Heyneman's study of 2293 7th grade students in Uganda (1976). In the Farrell and Schiefelbein study a small but significant relationship was found between teacher SES background and language and mathematics achievement (Standardized Regression coefficient, Beta, was .0386, $p < .01$). 9/

Ryan found that "quality of secondary school" attended by the teacher was related to pupil achievement for the total sample ($r = .19$, $\rho = .167$), and for two of the three area subsamples. However, in one of these latter, the rural district Karaj, where 85% of the teachers are female, the relationship is negative ($r = -.15$). Ryan concludes that "quality of secondary school" is a proxy for socioeconomic background and is normally positively related to student achievement, except for the "big city girls from relatively better off families [who] do not flourish in rural environments" (p. 97)

Heyneman, on the other hand, using level of parental education only, found the zero-order coefficient to be -.135 and not significant. All studies used aggregate data for teachers, though Farrell and Schiefelbein and Ryan used individual student scores while Heyneman used mean achievement scores for schools.

One possible explanation for the discrepancy between the Chile and Iran data and the Uganda study might be found in differences in the class structures of the countries, and the socioeconomic composition of the teaching staffs. In a recent paper, Heyneman (n.d.) suggests that the SES of students appears to have little consistent effect on achievement in LDCs, and that the explanation might lie in the underdeveloped class structure of some LDCs where upward mobility and SES differences are found only among the first generation of students. Could this not also be the case with teachers in some LDCs, and in particular Uganda? Thus in societies where class differences are more developed, such as Chile and Iran, teacher SES background could affect the relationship between teacher and student while in "newer" LDCs, where traditional culture is more homogenous, SES remains a relatively weak and unstable social factor.

Thus propositions concerning the link between teacher SES and effectiveness must be made with caution, and only with reference to specific societal contexts.

9/ Teacher SES was operationalized as a compound produced through factor analysis. The variables included were: education of teacher's father and mother, father's occupational prestige, and teacher's level of formal education.

4. Frequency of English in Childhood Home of Teacher

In order to further tap the significance of both verbal ability, and perhaps SES, Heyneman (1976) measured the frequency with which English was spoken in the childhood home of teachers. He found no relationship, however, with a resulting zero-order correlation of -.198. As this variable is probably linked with SES of teacher, the explanation follows that given above.

B. Teacher Qualifications

This dimension focuses directly at the main purpose of this report, namely to identify and assess the importance of teacher variables related to training which have an effect on student outcomes. An examination of the 32 studies covered here have produced five variables which have been placed in this classification: years of education, type of teacher qualification, level of cognitive ability, teacher experience (or seniority), and participation in upgrading or refresher programs. Clearly if strong relationships between student achievement and these qualifications variables are consistent, the policy implications for raising school outcome is readily apparent. It should be noted, however, that a major controversial issue concerns the fact that these variables have not shown consistent relationships with achievement outcomes in LDC studies (Alexander and Simmons, 1975).

5. Teacher Educational Attainment

It is generally assumed that educational attainment produces the cognitive competencies and skills necessary for effective training. Indeed the amount of education is often crucial in industrialized societies for certification requirements, the accreditation of schools, salary promotions, and in teaching-training programs(Charters, 1963). At the same time, however, it has been suggested that, at least for some kinds of teaching (i.e. early primary, only modest levels of educational attainment by teachers is really necessary). 10/

If exposure to schooling by prospective teachers has any cumulative effect on ability, and by implication on teaching success, one would expect that teachers with more schooling would be more successful, in terms of student achievement, than the less schooled. However, the evidence from LDCs is not at all clear and, in fact, suggest the absence of such a relationship. Of the eleven separate studies which include teacher educational attainment in the analyses, only four report significant positive associations (see Annex Table IV.5). This lack of evidence is even more impressive when one considers the diversity and quality of the studies which have examined this variable.

10/ Personal communication from Gabriel Carron, IIEP Paris, March 18, 1977. Carron was referring specifically to literacy and early primary teaching by relatively "uneducated" teachers in Cuba, and untrained teachers in the German Democratic Republic.

The four studies showing direct lines between teacher years of schooling and student performance are Carnoy (1971) for primary grades only, Husén (1977) for primary grade mathematics achievement, and Purves (1973) for Chile and Iran Population II (14-year-old) achievement in literature.

Carnoy analyzed the 1967 School Survey Data from one-third of the schools in Puerto Rico for grades 3, 6, 9 and 12, using Spanish Reading and General Ability examination results as criteria variables. The teacher data were taken from school records, and all data were aggregated at the school level. Measured as "years of schooling", Carnoy found that teacher educational attainment was positively and significantly related to performance for both achievement criteria for grades 3 and but not grades 9 and 12. Furthermore, the effect of teacher schooling level was stronger for low SES pupils at the primary level.

Husén's study of 869 Standard 7 pupils in Botswana found that the years of basic education of teachers was positively and significantly related to achievement in mathematics but not in reading comprehension. This distinction seems to support the notion that skills such as science and mathematics may be more related to teacher ability than reading, which in turn may be more related to background factors. 11/

Purves found that teacher education was significantly related to literature achievement (not the same as reading comprehension) for the 14-year-old (Pop. II) students for the IEA data from Chile and Thailand; it is interesting that no such relationship was found for older students in the final year of high school, which is somewhat consistent with Carnoy's findings, noted above.

Against these four positive findings, there were seven where no relationship between teacher schooling and student performance was found. Most notable here are the studies by Izguierdo and Guzman (1971), Fuller and Chantavanich (1976), and Heyneman (1976a,b).

Izguierdo and Guzman studied 519 primary school students in Mexico with respect to mathematics and language achievement, and report the zero-order correlation between achievement and schooling of teachers to be -.069 and not significant. Likewise, in their National study of 27,897 grade 3 pupils in Thailand, Fuller and Chantavanich found only .11 and .12 zero-order coefficients for beginning and end of year achievement in mathematics and Thai. In this regard, Heyneman's finding from his school-level analysis of Uganda grade 7 pupils in 67 schools is perfectly consistent, as the zero-order relationship between mean teacher years of schooling and mean school achievement

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11/ Husén's data do seem to support this contention, as home background variables of students (especially parents' education and reading and writing ability) appear more strongly related to reading comprehension than mathematics achievement (see Table 36).

was -.11. Finally, Levy (1971) also failed to find a relationship between years of schooling and dropout rates in her analysis of 42 LDCs, with data aggregated at the country level.

What, then can be concluded from these mixed results on the effects of teacher educational attainment? First of all, it must be noted that all of the studies cited, except Levy's, used teacher data aggregated at the school level. This clearly has the effect of minimizing individual teacher effects on educational students. Furthermore, if the allocation of teacher to schools is such that there is an equal distribution of teacher quality between schools, then the levels of analysis and statistical procedures could not possibly locate relationships, as there would be little teacher variance with which to explain achievement variance. Heyneman's (1976b) exploration of this possibility with respect to his Uganda data is particularly relevant and useful on this point. Thus the mixed relationships may, in fact, result from differences between countries in the distributions of teachers of varying quality between schools.

Thus the Carnoy, Husén, and Purves studies are important, since they deal with several samples within the same country, differentiating between grade level and/or achievement criteria, and all found at least one positive relationship. If one assumes that the distribution of teacher quality in these countries is uniform, then the mixed findings which each reports are informative. One might tentatively hypothesize on the basis of these results that teacher schooling is more important for achievement in the earlier rather than later school grades, and for those subject areas (such as mathematics, science, and literature) which are more dependent on school factors as distinct from home background factors.

6. Teacher Credentials and Certification (Level of Training)

Although there has been considerable debate in North America and the UK about the impact of teacher training on teacher success (Morrison and McIntyre, 1969), results from the IEA study of mathematics achievement in 12 developed countries appear to leave little room for doubt. For all student populations, and in virtually all countries, the relationship between "length of teacher training" and mathematics achievement was positive (29 out of 34 correlations; Husén, 1967:270-271). However in their survey of LDC studies, Alexander and Simmons (1975) found little evidence of teacher training effects, at least for early grades, and concluded that "teacher certification and academic qualification are not important at primary and lower secondary grades" (p. 54).

Teacher qualification variables were the most numerous of the teacher variables among the 32 studies of this report, as one-half (16) of the authors incorporated some form of training measure. Counting the IEA samples as separate studies, there are thus 24 results to assess.

Unlike the previous teacher variable, i.e. teacher level of schooling, the pattern of relationships here are somewhat more consistent. There were 13 positive relationships, 9 null relationships, and two negative relationships among the findings (see Annex Table V.6).

The case for the direct importance of training for teacher success is reasonably strong. On the one hand, the studies by Fuller and Chantavanich (1976), Husén (1977), Youdi (1972), Comber and Keeves (1973) and Beebout (1972), are consistent in their conclusions that students perform better with more highly trained teachers. Fuller and Chantavanich's already-mentioned national study of Thai 3rd grade pupils included a measure of the "degrees the primary school teacher received especially in professional training programs" (p. 11). The zero-order correlation for this variable with mathematics and Thai tests at the beginning and end of grade 3 were .159 and .093. The Beta coefficient for the regression of the independent variables on end-of-year achievement was .072, but this only increased the amount of variance explained in the model from .322 to .327.

Like the findings for teacher schooling, Husén found that teacher training was related to one achievement subject but not the other; in this case, trained teachers were more successful for reading achievement than mathematics ($F = 4.65$, $p < .05$ and NS respectively). However it should be noted that rank-order correlations between schools resulted in significant relationships for both reading and mathematics ($S_r = .48$, $p < .001$ and $.42$, $p < .01$ respectively). Husén explains the apparent discrepancy by observing that "untrained teachers [in mathematics] at this level are exceptions who most likely have proved to be skillful in order to be assigned to Standard 7 classes" (p. 35).

Of the science achievement results, Comber and Keeves found that at the Pop. IV level (final year of high school), four of the six correlations for Chile, India and Iran were positive and significant, and furthermore, all three of the between-student correlation (with aggregated teacher scores) were significant.

Finally Youdi's (1972) study of 1350 grade 11 and 12 students in the Congo likewise found that trained teachers were more successful in French and mathematics achievement, but the actual figures are not reported. Compared to other variables in the model, Youdi observes that "the average training of teachers in a school was found to be the most important independent variable in explaining the school mean scores in mathematics and ATT" (p. 99).

Finally Beebout's (1972) study of 7,674 pupils in 89 public secondary schools in West Malaysia provides strong support for the beneficial effect of teacher training. Using percent graduate teachers as the operational variable, Beebout reports a correlation of .268 between training and performance on standardized achievement examinations. When multiple regression procedures were executed separately for Malay and English medium schools, the beta coefficients were .345 and .012 respectively, indicating

greater training effects in the former. Furthermore Beebout found interaction effects between teacher qualifications and experience so when the proportion of qualified teachers in a school was high, the impact of teacher experience was low, and vice versa. This is an important insight into the interplay between teacher variables and might explain some of the null or negative findings in studies with less complete data.

Indirect support for the above findings are found in the studies by Bibby and Peil (1974), Currie (1977), Klees (1974), and Williams (1965). The first two of these studies used surrogate measures for teacher quality, namely school status and academic quality of school respectively. Bibby and Peil found that for the eleven schools and 585 students in their Ghana sample, school status was more important than home background ($\xi^2 = .41$; $\beta = .28$) in accounting for student examination performance. Likewise Currie's analysis of occupational careers of secondary school graduates in Uganda for the years 1954, 1959, and 1964, found that for the first and last cohorts, Betas for academic quality of school were .31 and .17, the highest of the independent variables. No explanation was given as to why the 1959 cohort showed different results, i.e. a negative coefficient ($\beta = -.14$).

Both Klees' study of Telesecundaria schools in Mexico and Williams' analysis of dropout rates in Guatemala supported the notion that trained teachers are more successful than the untrained. However their analyses are less direct and add little to the above studies, except to note the consistency of their results.

The null and negative findings must now be considered. The most important of these are Heyneman's study of Uganda 7th grade students, Ellson's experimental study of 1st grade reading gains in Malaysia using trained and untrained teachers, and the four non-positive IEA results for science (between-school) and French achievement. Although the studies by Silvey (1972) and Somerset (1968) in Uganda and Windham (1970) in Sierra Leone give negative support for the importance of teacher training, the measures are proxies, (for example, school quality) from which the effects of training can only be inferred.

As shown in Annex Table IV.6, Heyneman found the between-school correlation between teacher "status grade" (based on amount of schooling and training) and achievement to be -.09 and not significant. However as already mentioned, Heyneman provides his own answer for the null relationship between teacher variables and achievement in the equitable distribution of teacher quality between schools. He does not argue that his null findings provide negative proof for the importance of teacher training for maximizing student achievement (Heyneman, 1976b).

Ellson's (1973) represents one of the few attempts to investigate alternatives to teacher training for certain kinds of teaching success. His focus was on the learning of reading by first grade pupils in ten Malaysian schools. A control and experimental group, with 98 students each, were given reading instruction by trained and "unqualified" teachers over a period of 55 school days. The unqualified teachers were mature adults with only an elementary school background (6 years). The trained teachers used conventional methods while the "unqualified" teachers used programmed techniques designed specifically to assist untrained teachers in reading instruction. After the experimental period, pre-test and post-test scores were compared with the result that the experimental group showed significantly higher reading gains than the control group. Ellson contends that this evidence demonstrates the feasibility of using programmed techniques with "untrained" teachers for the rapid and inexpensive expansion of the teaching corps in poor countries to meet basic educational needs and demands.

Ellson's report merits serious attention. It is not so much a negative finding for teacher training effects, as the pupils under the trained teachers also made substantial reading gains. But the notion that some grade levels and subject areas can be taught by other than conventional methods and teachers is consistent with comments made elsewhere in this report (see footnote 10/).

Ellson's results, however, must be regarded with caution. It is possible that the greater gains of the experimental group could have been partly the result of a "halo effect", i.e. the novelty of the experimental situation. Furthermore the criterion variable in the experiment was reading ability at the first grade level, which may be more influenced by home background and teacher characteristics not related to training, for example enthusiasm or encouragement. Would the same results have occurred for science or math?

There were four null or negative results among the eight IEA correlations. However two of them occurred in between-school comparisons on science achievement where real teacher effects may be underestimated (see comments regarding Heyneman, above). The remaining two were reported by Carroll (1975) with respect to French reading and listening achievement for Chile, Population IV. It is difficult to draw conclusions from these latter two results except perhaps that in foreign language teaching, effectiveness may be determined by other factors, such as prior non-academic knowledge of the language (see #4), or teacher experience. As already shown, teacher training may have an interaction effect with experience, which, in the case of final year students, may be the more important variable.

Although the cumulative evidence from LDCs is mixed, the strongest support seems to confirm the effectiveness of teacher training in maximizing student achievement. There are sound methodological explanations for the several studies which have failed to detect training effects, such as between-school rather than between-student comparisons, and the possible interaction between teacher training effects and experience or other factors.

Unfortunately, few studies have thoroughly investigated the more subtle factors which may obscure the influence of training, Beebout and Heyneman being exceptions. Although it may be that "untrained" or "unqualified" teachers may effectively teach some subjects such as reading (perhaps writing and numeracy) in first or second grade, the evidence suggests that trained teachers would normally be required to teach more advanced subjects to middle primary and secondary students.

7. Teacher Ability and Achievement

There were six author sets among the 32 who included measures of teacher cognitive ability or performance in their investigations of student performance in LDCs. With the four replications in Lewis and Massad's IEA English report, the total number of results are nine. Of these, five reported positive findings between teacher ability and student performance, three reported null relationships, and one reported a negative relationship.

All five of the positive findings are reported from methodologically sound and valid studies and provide strong cumulative support for the importance of teacher ability as a determinant of teacher success.

In Heyneman's study of grade 7 children (N = 2,293) from 67 primary schools in Uganda, English language competence was the single teacher variable which was significantly correlated with pupil achievement. Furthermore, when this variable was included in the multiple regression equation in Block 2: "In School Influences", the variance explained by the Block (of the total variance explained) was 31.7% as compared with 47.5% for Block 1: "Pre-School Influences". While there may be explanations for the absence of relationships for the other teacher variables, the importance of teacher ability cannot be overlooked. Clearly in the Uganda context, where much of the instruction is in English, knowledge of English will be an important teacher variable.

However, Ryan (1974) complements and expands on Heyneman's finding. In Ryan's study of 797 grade 2 students in Iran, teacher ability was measured by average results of government secondary examinations. The zero-order correlation between this measure and pupil achievement was .14, and as such not impressive. However, when multiple regression analyses were performed on the separate regions covered by the study, Ryan found that the importance of ability was most pronounced in the most rural and poorest (β = .353). Ryan thus concluded that high quality teachers have the greatest impact on the more disadvantaged pupils. Not only is this finding similar to that reported by Heyneman, but it is also consistent with the results of the Coleman Report.

Of the four IEA results reported in the English as a Second Language survey, three were significant at the .01 level. For Chile, Pop. IV, achievement on both English reading and listening were related to a measure of self-perceived ability by the teacher in various English-speaking skills. Pop. II English Reading achievement in Thailand was also directly related to teacher ability, but not Pop. IV Reading Ability, which was negative. There is no apparent explanation for the latter deviant finding.

The null relationships were reported in the Fuller and Chantavanich study in Thailand and Izquierdo and Guzman's, and Schmelkes' studies in Mexico. With respect to the latter study by Schmelkes, the focus was on the effects of radio teaching on achievement in mathematics and language. In this particular context, it was concluded that the radio overcame the lack of knowledge or ability in the teacher, thus rendering teacher cognitive ability unimportant.

On the other hand, Izquierdo and Guzman investigated the importance of teacher variables on the achievement of 519 3rd, 4th and 5th grade students, and found that only one, teacher experience, was related to achievement. However a closer inspection of the authors' other findings indicated that all school facility variables correlated with achievement, suggesting that the better schools had better teachers, as well as the better students, so that there was little variance to explain in the correlations.

Finally, the Fuller and Chantavanich study of a large national sample of Thai grade 3 pupils included results of cognitive test batteries performed on the teachers, which did not correlate significantly with pupil performance either at the beginning or end of the grade 3 school year. As a result this variable was not entered into the multiple regression equation. While this study is clearly sound, it is useful to point out that the zero-order correlation was performed on the total sample, rather than stratified segments. This is particularly crucial in dealing with a national sample in a country with considerable regional disparity, which the authors document. Thus it is likely that the overall effect of teacher ability on achievement is underestimated, especially since one would not expect its effect to be uniform over the different regions (see the comments on Ryan, above).

In conclusion, it would seem that the weight of the evidence is in support of the argument that high quality teachers will produce better results among students. This relationship may not hold across all students, especially for the better ones from advantaged backgrounds. However there seems little room to doubt the importance of teacher knowledge and ability for the performance of the less advantaged, which in LDCs, is a most important consideration.

8. Teacher Experience

Nine of the 32 studies included a measure of teacher experience, but counting replications, there were a total of twelve results upon which to assess the importance of this variable. All other things being equal, it is generally agreed that a teacher gains skills through experience, and that the more experienced teacher is the more successful teacher. In their study of nine LDC studies, Alexander and Simmons (1975) concluded that experience contributes to teacher success in primary and early secondary grades, but not in upper secondary grades.

The evidence from the studies in this report generally support the above conclusion. Seven of the twelve results showed positive relationships between teacher experience and pupil achievement, two showed null relationships, and three showed negative relationships (see Annex Table V).

The studies which found positive relationships are by-and-large methodologically sound and vaid and merit serious attention. As already mentioned, one of the most insightful of these studies with respect to the experience variable is that by Beebout (1972). In this investigation of 89 Malaysian schools (N = 7674), Beebout found only a modest overall relationship between teacher experience and upper secondary students in Mathematics and Language achievement (r = .031). However when interaction effects with teacher qualifications were taken into account, the relationship increased (r = .268). In other words, as the proportion of qualified teachers in a school increased, the effects of teacher experience decreased, and vice versa. As already mentioned (see #6 of this section), this finding appears extremely important for the assessment of teacher impacts in general, and is the only study which has identified and reported such a process.

Carnoy's (1971) study of the 1967 School Survey data (182,000 pupils in grades 3, 6, 9 and 12) casts further light on the impact of teacher experience in teaching success. In general, the relationships between the two were strong for the 3rd and 6th grades and weak to negative for the 9th and 12th grades. While there were few differences between rural and urban samples (the rural were slightly more positive and more negative), the overall pattern was more pronounced for reading than for general ability. This latter might have been due to the nature of the general ability examination which tapped fewer specific school-learned skills. An example of the Beta coefficients were as follows: 3rd grade urban reading = .384 compared with -.652 for 12th grade urban reading.

Carnoy's main contribution lies in the suggestion that experience is more important for earlier grades than for upper secondary, where more skill and knowledge are required.

Other important studies supporting the above findings are Thias and Carnoy's (1972) study of Kenya students on the final leaving examination for grade 7, and Husén's study of Botswana Standard 7 students on Mathematics and reading achievement.

Using seniority as a measure of experience, Thias and Carnoy found that seniority was a better predictor of examination performance than formal qualifications. They concluded that "seniority may reflect the beneficial effects of having a stable staff, since the older, more senior teachers are less likely than younger ones to be transferred to other schools, regardless of qualifications" (p. 151). Likewise Husén found very strong associations between teacher experience and achievement scores, with F-values of 4.13 and 3.80 for reading and mathematics respectively, both of which were highly significant. Husén notes that these findings may be due either to the effects of teaching experience per se, or in fact may denote that experienced teachers

are assigned to schools with better resources and students. Ultimately, however, he concludes that "... it would seem that teaching experience as such is an important factor" (p. 36).

What can be said about the null and negative findings concerning the impact of the experience variable? Heyneman's (1976b) already mentioned explanation for his failure to find significant relationships for most of his teacher variables must be kept in mind here. Heyneman found a zero-order correlation of -.03, NS, between teacher experience and achievement. If one can assume that teachers are graded and allocated between schools on the basis of experience as well as qualification, then the null finding does not constitute negative evidence, but only that schools in Uganda were equal with respect to teacher quality, thus with little variance for the between-school analysis to explain. Unfortunately Heyneman did not investigate the interrelationships between the teacher variables themselves to further clarify the manner in which the teacher experience variable was distributed vis-a-vis other teacher variables, or interacted with them in association with achievement.

The remaining null and negative findings do not seriously challenge the pattern already discussed. Klees (1974), for example, reported a negative association between experience and pupil performance in Telesecundaria schools of Mexico. However his results are linked with the use of television teaching, and as with other variables in his analysis, illustrate that the television may compensate for lack of other teacher qualities. Furthermore, Klees' study was of secondary students, where, as already mentioned, the effects of experience seem to be the weakest, or perhaps the most evenly distributed between schools.

This latter explanation also applies to the two non-supportive findings reported by Carroll (1975) for Pop. IV achievement in French in the Chile sample. The fact that the sample consisted of final year secondary students actually is consistent with the contention of others that experience becomes less important for upper secondary grades.

The cumulative evidence supporting the notion that teacher experience contributes to teacher skills and success, at least for some grade levels, is persuasive. The pattern of the eleven findings reported here indicate, with some consistency, that teacher experience is most important for lower grades and least in upper secondary grades. Furthermore, the interaction between teacher experience and qualifications as reported by Beebout probably suggests that older and experienced teachers (in his sample, at least), are less likely to have the same credentials as younger teachers, or that experienced teachers have drifted to the same schools. Whatever the explanation, to reject the value of teacher experience for student performance, at least for some grade levels, would be completely unwarranted according to the evidence presented here.

9. Teacher Salary

The salary of a teacher correlates highly with qualifications and experience, which is probably one reason why it has not received much attention in achievement research in LDCs. Only three studies included measures of salary, two of which found positive relationships between it and achievement. In their study of 585 students in eleven Ghana schools, Bibby and Peil (1974) found that school status effects on Ordinary Level G.C.E. (General Level Examinations) were higher than home background effects (ε = .41 and β = .28). Although teacher salary was not measured directly, the authors contend that status of school was a surrogate for several teacher characteristics. Thus in low status schools, it is argued that teachers are seldom qualified and their salary is frequently low and irregular. Therefore high school status effects on achievement can be interpreted as partly due to teacher qualification and salary effects.

The somewhat indirect findings of the Bibby and Peil study are supported by those of Thias and Carnoy (1972) in their study of both primary and secondary students in Kenya. Using aggregate school data and multiple regression strategies, they found that average teacher salary was significantly related to examination outcomes at both school levels. It should be noted, however, that the authors did not feel that an increase in teacher salaries would appreciably improve average student performance, since it accounted for only a fraction of total variance in performance.

The single null finding concerning the link between teacher salary and student outcome is Levy's between-country analysis of 42 LDCs, using primary school dropout as the criterion variable. Using stepwise multiple regression procedures, Levy did not find any of the four teacher variables to be significant. These null findings are probably due to the aggregation of the data at the country level, which undoubtedly masks many effects at the school or individual levels.

It would be difficult to draw any firm conclusion from the findings reported here. In all likelihood, teacher salary is highly intercorrelated with other teacher quality variables, and contributes little independent effect. Nevertheless research evidence is scant and only further enquiry can determine the policy potential of this variable.

10. Teacher Upgrading Programs

Only two studies included some measure of teacher upgrading programs and their effects on teacher success. The first of these is Husén's study of Standard 7 Botswana students, where the extent of in-service training by teachers was measured. The results showed that teachers who had participated more in in-service programs were more successful in both mathematics and reading achievement by students.

A more direct test of the effectiveness of upgrading programs is found in Nasoetion, et al (1976). This study is unique in several respects. Firstly, it is one of the few studies of teacher effects using an experimental design. Secondly, the study was coordinated with a large-scale educational development project in Indonesia to introduce new textbooks in four subjects: social science, mathematics, Bahasia Indonesia, and science. Part of the development program consisted of teacher upgrading to prepare for the new text materials. Although the development program was to be introduced gradually, grade by grade, the evaluation of its success was conducted on grade 5 students in Bahasia Indonesia achievement.

The study design called for five groups of students and teachers, according to whether new or old textbooks were used, and whether teachers had not been exposed or exposed, one, or three times to upgrading sessions. Each cell contained eight schools.

The zero-order correlation between upgrading and post-test reading achievement was .146. In general, the authors concluded that the new textbook did not result in better learning than the old textbook. However, in the multiple regression equation, teacher upgrading was found to have a positive effect on both teaching performance and student learning (the increment in variance explained (R^2) was only .1061 to .1103, or an increase of .0042, p. <05). It was further found that interaction effects between the new textbooks and upgrading were significant and contributed to the amount of variance explained. The wisdom of introducing both textbooks and upgrading was underscored, although the independent effects of upgrading represent an important contribution to possible policy measures for quick and inexpensive improvement of student outcomes in developing countries.

C. Teacher Behavior and Attitudes

On the whole, the effects of teacher behavior and attitudes, especially within the classroom, have received considerable research attention by educationists and social scientists in western industrialized countries (Dunkin and Biddle, 1974). In spite of the fact that cumulative research clearly demonstrates the direct effects of at least some teacher attitudinal and behavioral variables on student achievement (see, for example, Part I), there remains considerable uncertainty as to whether these variables can be taught through teacher training programs, or whether they are the result of background and personality factors. Irrespective of which alternative ultimately proves to be true, it is worthwhile to direct attention to this set of variables in LDCs as they can be policy-manipulated either way. Teacher training programs can be oriented to teaching teachers desired classroom behavior, and/or selection and recruitment procedures can maximize the intake of those candidates who are most likely to manifest the desired behavior.

In this section, attention will be directed to five variables: teacher expectations of students, teaching methods (TV, radio, etc.), teacher absenteeism and punctuality, teacher attitude toward job, and aspects of teacher behavior (homework assignment and time spent in lesson preparation). The final variable in this section is actually the Block variable used by the IEA analyses. Although the Block receiving focus is generally called "School Conditions" by IEA authors, it includes whatever teacher variables are allowed to enter the equations using stepwise techniques.

11. Teacher Expectation of Students

The so-called "Pygmalion-effect", whereby pupils conform to the expectations of their teachers, has been much discussed and researched in western countries (Rosenthal and Jacobson, 1968). Unfortunately the same has not been the case in LDCs, where only four of the 32 studies included a measure of this variable. However all four of these studies reported positive results, two of which are particularly strong and noteworthy.

The first has already been much discussed in this report, namely Fuller and Chantavanich's (1976) national study of 23,555 grade 3 pupils and 987 teachers in Thailand. Conducted in 1973, with the student achievement measures the composite of Thai and arithmetic examination scores, for both pre- and post 3rd grade attendance, the study included a variable to assess the teacher's view of the children's learning ability in terms of good, fair, or poor. The zero-order correlations (between student analyses) between teacher's perception and student achievement were .217 and .228 for beginning and end of grade 3 respectively. These values are highly significant and noteworthy by any standard. When entered into the national multiple regression equation, the variable entered 5th using stepwise procedures and increased the R^2 = from .307 to .317. On the basis of these figures, given the limitations of the methodological strategy, the support for the direct effect of positive teacher perceptions is strong.

A national study by the Philippines Department of Education and Culture (1976) on 5th and 6th grade students for achievement gains between the two grades in nine subject areas focused specifically on the effects of teacher expectation. Approximately 29,000 students were included in the 6th grade sample and 2,930 in the 5th grade (control) sample. A straightforward cross-tab analyses showed that the "teacher's evaluation of students is an important determinant of academic performance" (p. 86). Furthermore the researchers found that as the teachers evaluation becomes more positive, the students' performance increases above the levels of their own self-esteem. This finding was considered to be of "capital" importance and while still subject to verification, "should already be made to affect the attitudinal components of teacher training" (p. 87).

The remaining two studies add further support to the above findings. Durojaiye (1974) studied 540 students in Standards I, II, and III in rural and urban Uganda schools. Teacher ratings of pupils were according to (i) industry and effort, (ii) punctuality and regularity, (iii) reliability and honesty, and (iv) predicted academic progress. The zero-order coefficients for rural boys and girls were .162 and .14, and for urban boys and girls were .113 and .146. While no controls were introduced, it should be noted that the coefficients between SES of student and achievement were all negative, ranging from -.541 for rural boys to -.098 for urban girls.

Finally, Rowe's (1966) in-depth study of 100 failures and 50 top students in grade 4 Hong Kong schools again underscored the importance of teacher expectations for student performance. In the only study of this design in the LDC literature, Rowe found that teacher expectations were more consistent with pupil achievement in arithmetic than in Chinese or English, which conforms to earlier discussions about the stronger school link with mathematics learning. Rowe also noted that the home environment, particularly the mother, was of "paramount" importance in explaining failure.

Although there were only four studies which included teacher expectation variables, the diversity of research designs and the consistency of results with each other, as well as with the body of literature in developed societies, give strong support to the possible effectiveness of this variable in raising performance levels.

12. Teaching Method

This variable includes those studies which have attempted to evaluate various technological alternatives to conventional teaching methods, i.e. instructional television, and various forms of programmed teaching. Insofar as these methods are only marginally related to teacher training variables which are the main focus of this report, the discussion of these four studies will be somewhat brief.

Two of the studies are evaluations of Instructional Television (ITV) in Mexico (Keeves, 1974) and El Salvador (Hornik, et al. 1973). Both of these projects have produced considerable literature (see, for example, Mayo, McAnany and Klees, 1975, and Mayo, Hornik and McAnany, 1976), but the two included here will be taken as representative examples.

The remaining two studies in this section are concerned with forms of programmed teaching: Okunrotifa's (1975) study of Nigerian 8th grade students' achievement in geography and Ellson's (1973) study of reading achievement among 1st grade students in Malaysia.

All four of these studies reported positive findings in favor of the alternate teaching method. Thus Klees and Hornik both report that students exposed to ITV in Mexico and El Salvador show higher gains, than those exposed to conventional teaching methods. Likewise, Okunrotifa and Ellson report that there were higher achievement gains by students exposed to teachers who were using programmed methods, even though, as in the case of Ellson's study, the teachers were "unqualified".

No doubt these studies give consistent and strong support to the possibility of alternative teaching strategies to bring about "rapid" and perhaps less-expensive improvements in student performances in LDCs. However, until more extensive experimentation and evaluation is pursued, these alternatives must be regarded with some caution. Carnoy and Levin (1975) raise two major objections to current evaluation studies of the type represented here. The first, the "benefit of the doubt bias", derives from tendencies to underestimate the true cost of these alternative teaching forms and to disregard other related factors, such as student selectivity. The second objection, the "ignoring other effects bias", derives from concerns about unquestioned assumptions underlying the use of alternative instructional methods, for example, the urban curriculum which is telecast into rural areas, assuming its effectiveness and relevance for rural teenagers.

It would seem that there is much research yet to be done before these teaching forms can be considered viable alternatives to face-to-face instruction by competent and concerned teachers.

13. Teacher Absenteeism and Punctuality

Only two of the 32 studies included measures of this aspect of teacher behavior. On the surface it would appear that absenteeism and punctuality are related to other teacher behaviors and attitudes, since job interest or responsibility might be affected, and thus teaching effectiveness as well.

However both studies report null relationships. Fuller and Chantavanich (1976) found that correlation coefficients for punctuality were .062 and .066 for beginning and end of grade 3 achievement. Furthermore, when added to the national multiple regression equation, the variable entered last according to stepwise techniques and added virtually nothing to the total variance (β = .012, NS).

Izquierdo and Guzman (1971) also included a measure of teacher punctuality in their study of 519 grade 3, 4 and 5 pupils in Mexico. The zero-order correlation was .077, NS, between this variable and mathematics and language achievement.

The little evidence which exists, seems to indicate that teacher absenteeism and punctuality are not important teacher factors in the explanation of variations of student performance.

14. Teacher Attitudes Toward Job and Career

As with the previous variable, one would expect that the attitudes toward teaching would affect teaching styles enough to make a difference in student outcome. The overall evidence, in the results here, however, is mixed.

Five of the 32 studies included measures of teacher job-related attitudes, two of which reported positive associations between attitudes and pupil performance, and three reported null association. None of these studies can be regarded as providing strong support or lack of it, for the hypothesized relationship, because of ambiguities in measurement (i.e. the use of "proxies") or methodological weaknesses.

Ryan (1974), for example, found a .17 correlation between teacher "frankness" and pupil performance in language and mathematics in his study of 797 grade 2 students in Iran. Furthermore, the significance of the variable remained when entered into the regression model for the total sample (β = .121, R^2 change = .013), and for two of the three regional subsamples, namely the two most rural and disadvantaged. However, it should be noted that "teacher frankness" was inferred from the teachers' openness and willingness to discuss local issues, and furthermore was used as a "proxy" variable for job security. It does not represent a direct measure of job related attitudes.

Durojaiye (1974) found in his study of 540 Ugandan secondary students that a positive attitude toward teaching pupils was significantly related to achievement for urban boys and girls (r = .253 and .212) but not rural ones (r = .011 and .073).

Among the null findings are those reported by Klees (1974), Izquierdo and Guzman (1971), and Somerset (1968).

Starting with the latter, it must be noted that Somerset only inferred teacher morale from the quality of the secondary schools in his Uganda study of Cambridge School Certificate candidates. Furthermore school quality was measured on the basis of average examination scores by students in the school. The addition of school quality made only an infinitesimal increase in variance explained (Multiple β = .3804 to .3807).

Izquierdo and Guzman's study of 519 grade 3, 4, and 5 Mexican students measured teacher attitudes more directly, but found a very small correlation, r = .002, NS. Likewise Klees (1974) found that teacher attitudes towards his or her job were unrelated to achievement in his study of Telesecundaria students.

The evidence here is mixed, and there are many reasons, already mentioned, why this is the case. Until more focused and direct studies of teacher career attitudes are available, any conclusions regarding this variable in LDC teacher training policies must be regarded as tentative.

15. Teacher Behavior

This variable includes the IEA measures of the extent to which teachers assign homework from student reports of hours spent doing homework and time spent on lesson preparation. One would expect that both of these behavioral characteristics would be favorably related to higher pupil performance. The evidence, however, is not clear.

Comber and Keeves (1973), for example, report five between-school zero-order coefficients and ten between-student coefficients relating hours students spend at homework and science achievement (see Table IV.15). Of the between-school coefficients, two are positive and significant, while the remaining three are non-significant (though positive). In the between-student comparison, five are significantly positive while five are not. There seems to be no consistent pattern by population, although by country Indian students who do homework seem to be more successful in science, than their counterparts in Chile or Iran.

With respect to hours spent in lesson preparation, there is a slight positive pattern which would suggest that this kind of teacher behavior is likely to result in greater student success in English as a second language.

Overall, the evidence from these two facets of teacher behavior do not provide clear guidelines which might be incorporated into teacher training policies. While the evidence is limited to zero-order relationships, with no controls, the nature of the IEA samples, the three age levels, and the four LDC countries suggest that the absence of consistent patterns should be taken seriously, at least until further research is forthcoming.

16. School-Teacher Block Variables (IEA Studies)

This final section represents a departure from the previous 15 teacher variables, in that it does not deal with individual teacher variables, but Blocks of variables which include school related variables as well, for example, in the IEA science analyses, number of laboratory assistants and the school behavior scale. In most of the IEA reports, this Block was identified as relating to the learning condition in the school.

A further departure from the previous fifteen variables concerns the number of reporting the findings. The IEA volumes typically reported the amount of variance explained by each Block of variables for the total variance in achievement. Thus, in this brief survey, the amount of variance explained by the School-Teacher Block is compared with the variance explained by Block 1, or the students' home background. The rationale behind this procedure is simply to compare the relative importance of school-teacher variables with home background variables, since these two have been the major focus for the current discussion of the determinants of student achievement. Where the proportion of variance explained by school-teacher variables is equal to or exceeds the variance explained by the Home Background Block, a "+" is recorded; where this is not the case, a "0" is recorded.

Overall, the general conclusions from the IEA studies was that "school variables appeared to have relatively little power in accounting for variations in achievement ..." (Platt, 1975:38). However if one inspects the importance of the school variables relative to Home Background variables, in the four LDCs as given in Table IV.16, this does not appear to be the case. Of the 56 comparisons available, the variance explained by the school-teacher block equals or exceeds that of the home background block in 41, or 68% of them. A couple of examples will illustrate the point. In India, Pop. I (10-year-old), science, 20% of the variance is explained by the school-teacher Block, compared with 1% by the Home Background Block. In Chile Pop. I, reading, the school-teacher Block accounts for 8.3% of the variance compared with 1.4% by the Home Background Block.

Are there any patterns either by subject, age level, or country which emerge? The answer is clear. In all subjects except literature, the School-Teacher Block accounts for equal or more variance than the Home Background Block. In general it appears that the School-Teacher Block explains more variance relative to home background variables for the Pop. I results, or the younger pupils. Finally, by country there seems to be a marked contrast between Chile, on the one hand, and India on the other. With respect to the former, the school-teacher variables are much weaker relative to the home background variables, as only 8 of the 20 results are positive. For India, the reverse pattern applies, as 22 of 24 results show the school-teacher variables to explain more variance than home background variables.

One should not exaggerate the implications of these trends for teacher training policy in LDCs, since the analysis by blocks obscures the unique importance of teacher-related variables. Furthermore, as already noted, the teacher variables differ from analysis to analysis, depending on whether they met the prescribed criterion for entry into the regression equation.

Nevertheless the overall pattern, as well as the subject, age and country variations is impressive. In contrast to the observations of Platt and others regarding the entire set of IEA findings, the results for the four LDCs seem to clearly indicate that relative to home background variables, the school-teacher variables are very important in explaining variations in student achievement. This pattern for the LDCs should be taken seriously, as it not only supports findings already discussed for the 15 specific teacher variables in this section, but underscores the differences between developed and less developed countries with respect to the determinants of student achievement.

IV. CONCLUSIONS AND POLICY RECOMMENDATIONS

The mandate for this review was to locate and critically assess relevant researches which investigate the impact of teacher variables on student outcomes in less developed countries. Section I of this review briefly described the background of this project and presented some findings from similar reviews of studies in western industrialized countries, mainly North America and the United Kingdom. Section II outlined the format within which the literature was organized. The 16 teacher variables were described. In Section III, the evidence for the importance of each variable was described and assessed.

The search located 32 separately authored studies which investigated teacher effects in LDCs. However some studies included several replications, either by grade level, criterion variables, or by country. Counting each of these separately, there were 64 studies to analyze.

(i) Some Comments on the Interpretation of Results

As described in Appendix A, some conceptual and methodological considerations should be kept in mind when assessing the findings of these studies.

The 32 studies included a variety of research designs and methodological strategies. On the basis of the observations in Appendix A, many of the results discussed in this report must be regarded as tentative and possible underestimates of true relationships between variables. Cross-tabular analyses and zero-order correlation coefficients do not take control variables into account, and thus there is always the possibility that a relationship might be spurious and due to intercorrelation with another variable. Thus, for example, the correlation between teacher age and achievement might be due to the fact that older teachers are more experienced and also more stable.

Many of the results considered in this report are in the form of zero-order relationships, which are particularly vulnerable to the above limitations. However, rather than dismiss them altogether, it is more practical to utilize these findings as preliminary indicators of the real link between teachers and pupils. Until more sophisticated research is available, some information is preferable to none, especially where policy-making is concerned.

(ii) Summary of Findings

Conclusions for each teacher variable are briefly summarized as a prelude to the policy recommendations.

1. Teacher Sex shows mixed results, but generally male teachers seem to be more successful with science achievement, while females appear more successful with subjects like English and French as foreign languages. Furthermore, males seem to be more successful in early grades, at least in some countries.

2. Age of Teacher is equally mixed in results, but there is some evidence that for the later secondary grades, older teachers are more successful than younger ones.

3. Teacher SES effects are contingent on the social structure, though in general teachers from higher status backgrounds are more successful than teachers from lower status backgrounds.

4. Frequency of English in Childhood Home is a variable which has relevance in countries where English is a medium of instruction rather than the native tongue. In the one case where this variable was measured, it was unrelated to student achievement.

5. Teacher educational attainment also produced mixed results, however teacher schooling did emerge as more important for primary and early secondary grades, and for those subject areas requiring special skills, such as science, mathematics and literature.

6. Teacher credentials and certification are clearly important for successful teaching. Although the overall evidence is somewhat less than unanimous, the more complex and thorough studies provide strong evidence for the positive effects of teacher training on student outcomes.

7. Teacher ability and achievement are important teacher qualities for student achievement, especially for the more disadvantaged students. The most thorough studies of this variable indicate that intelligent and knowledgeable teachers produce high student performance.

8. Teacher experience is important for student performance in primary and early secondary grades, but less so for upper secondary grades. This finding is consistent with those of earlier literature surveys.

9. Teacher salary does not emerge as a consistently important variable in maximizing student achievement. The ambiguous results are probably due to the high intercorrelation between teacher salary and other teacher variables.

10. Teacher upgrading programs have received little attention in the research literature, but the two studies reviewed in this report suggest that such programs are effective.

11. Teacher expectations of students are among the most consistently important variables in the achievement literature. Positive teacher expectations of students produce positive results.

12. Teaching methods such as instructional television and programmed instruction have been found to correlate positively with student achievement. However the research so far has been seriouly questioned and the findings should be regarded with caution.

13. Teacher absenteeism and punctuality, although only little researched, do not seem to be important teacher characteristics in relation to student performance.

14. Teacher attitudes toward job and career did not clearly emerge as an important variable, in spite of sound theoretical reasons why it should be so. Until further evidence is forthcoming, the relationship between positive job attitudes and student performance must be regarded as mixed and ambiguous.

15. Teacher behavior, operationalized as the assignment of homework and time spent preparing lessons, did not clearly emerge as an important variable and thus of dubious value in teacher training programs, at least in isolation from other more important "trainable" teacher characteristics.

16. School-Teacher Block variables (IEA studies) provided overwhelming evidence that at least in LDCs, the conditions surrounding the school and teachers are important in accounting for variations in student achievement. The evidence was strong and atypical in comparison with the results for the developed countries in the IEA samples.

Some comment is required in order to avoid simplistic interpretations of the mixed evidence found among the 32 studies covered in this report. The findings can be summarized for all samples and all variables together in Table I, designating a statistically significant positive effect by "+", no effect by "0", and a negative effect by "-". Although the results in Table I are mixed, a clear pattern can be seen: the bulk of the studies show significant positive effects, a smaller number show no effects, and few show negative effects.

Table I: SUMMARY OF FINDINGS FOR ALL SAMPLES AND ALL VARIABLES TOGETHER

	+	0	-	Total
Number	110	65	19	194
Per cent	57	34	10	100

Studies concerned most directly with teacher qualifications (educational attainment, credentials and certifications, ability, experience, salary, and upgrading programs) are summarized in Table II. Again the pattern is clear:

Table II: SUMMARY OF FINDINGS FOR VARIABLES CONCERNED WITH TEACHER QUALIFICATIONS

	+	0	-	Total
Number	35	22	6	63
Percent	56	35	10	100

the bulk of the studies show positive effects, a smaller number show no effects, and few show negative effects.

Some studies summarized above should be given greater weight than others, due to the variables examined and the analyses carried out. In Table III, therefore, the results are summarized for 11 carefully selected studies. Three criteria were used in this selection: (1) the studies related specifically to teachers' years of training or type of qualification; (2) the studies report results of analyses involving either experimental or statistical control for student background characteristics; and (3) the teacher training variable is measured rather than inferred from salary or other school or teacher characteristics. 12/ Here again the pattern is clear:

Table III: SUMMARY OF FINDINGS FOR ELEVEN SELECTED STUDIES CONCERNED WITH TEACHER TRAINING

	+	0	-	Total
Number	6	3	2	11
Percent	55	27	19	100

the majority of studies show positive effects, a smaller number show no effects, and few show negative effects.

12/ The studies included here are: Beebout (1972), Bibby and Peril (1974), Carnoy (1971), Carroll (1975), Currie (1977), Ellson (1973), and Fuller and Chantavanich (1976). Each sample and each measure is counted as a separate study. The reader is referred to ANNEX Tables I, III, IV and V for details.

It is maintained that the observed distribution of the results of the studies reported here reveal a pattern which is not consistent with the null hypothesis (the hypothesis that teacher characteristics have no effect on student achievement). This can be illustrated in Figure I. If the null hypothesis prevailed, i.e., if teacher characteristics did not have any effect on student achievement, sampling error and non-random measurement error would lead to an observed distribution of estimates of teacher effects on student achievement centering on zero, as illustrated by Curve I. The bulk of the studies would show no effects, and a few would show positive effects and approximately the same number would show negative effects.

Figure 1

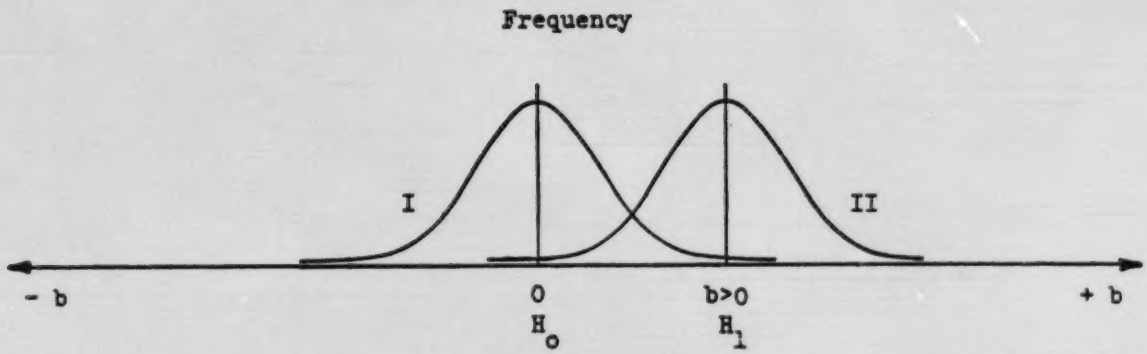

Figure 1. Distribution of Observed Estimates Under H_o and H_1

In the studies reviewed here, however, the distribution of estimates of teacher effects clearly centers on a value greater than zero, as illustrated by Curve II. It may, in summary, be concluded that the results reported here constitute evidence of a positive effect of teacher characteristics on student achievement and are inconsistent with the null hypothesis. It should be noted here that the two analyses presented in Part II of this report give further support to this conclusion. If these two analyses were added to Table III, the percent figures in the table would be 62 percent "+", 23 percent "0", and 15 percent "-". The studies in Part II are of special importance since they were designed specifically for the purpose of testing the effect of teacher training taking into account all the problems we are aware of in the studies reviewed here. Further studies using better controls and more percise instruments will be required in order to obtain a satisfactory estimate of the magnitude of the effect of teacher training and other teacher characteristics.

Overall, one can conclude from the evidence of the 32 studies covered by this report, that at least some teacher variables have emerged as very important in explaining variations in student achievement in LDCs. By far the most impressive evidence focused on variables linked with teacher qualifications and credentials. Contrary to the arguments presented elsewhere, the evidence here suggests that trained teachers do make a difference. Furthermore, teachers with more experience and with higher levels of ability and knowledge appear more successful than those not so well endowed. However, these statements need some qualification, since apparently these consequences of competence do not operate out of specific social and cultural contexts. Thus, for example, it seems that credentials are more important for those subject areas which require special skills and knowledge, and which are much more dependent on the school for learning, such as mathematics and science.

On the other hand, teaching experience appears more important for the primary and lower secondary grades, which is near the primary levels for which "untrained" teachers may act as substitutes for the trained, given appropriate programmed teaching instructions. But whether this latter practice will work for any subject area is a matter for further research.

With respect to teacher demographic and background characteristics, again the evidence is somewhat ambiguous. What is certain, however, is that there are differences between young and old, and males and females, with respect to teacher effectiveness. Naturally the effects of these two variables are contingent upon specific contexts. However, at least in some countries, it seems that males are more successful for early grades, and the older teachers seem more successful in the secondary grades. The slight discrepancy between the findings with respect to age and experience is not clear, but there may be interaction effects between these two variables which merit further investigation. Finally, teachers from upper status backgrounds are generally more effective than those from lower status origins.

Attitude and behavior variables do not present an altogether clear picture either. Without question, favorable teacher expectations of students are extremely important for successful student performance. However, it seems that aspects of teacher behavior such as absenteeism, punctuality, giving homework or preparing lessons, and attitudes toward one's job, are all moderately or of minor importance.

A final observation must be made at this point. The interaction effects found to operate between teacher credentials and experience is an important factor to keep in mind. Few studies have actually examined interactions between teacher variables with respect to student outcomes. Yet the inconsistency of some of the findings may be due in part to interaction effects. Thus until we know more precisely within what contexts certain variables have an effect, we will be unable to completely understand how teacher characteristics produce results in the classroom.

(iii) Some Unresolved Questions

The studies reviewed in this document provide us with a fairly comprehensive picture of the importance of some teacher characteristics for student achievement. Nevertheless several questions outside the scope of this report remain unanswered, but should be noted because of their possible influence on policy-making for teacher training programs in LDCs. These questions concern: (1) threshold effects of teacher training, (2) the effects of teaching styles, and (3) the relative efficiency and costs of alternate programs for teacher training.

(1) Threshold Effects:

Frequently during interviews with experts for this report, the problem of "how much" teacher training was raised. In other words, it was often felt that beyond a certain "threshold", additional teacher preparation would likely prove unimportant in raising performance levels in developing countries, thus wasting scarce resources, both in terms of costs and facilities.

However, this upper threshold, whatever it might be, was not felt to be of immediate concern for teacher training programs in most LDCs and thus the expansion and upgrading of existing programs was seen to be a viable goal for the improvement of educational systems.

Unfortunately none of the studies reviewed in this report took threshold effects into account, either directly or indirectly. Thus, for example, when Thias and Carnoy (1972) calculated the marginal gains in earning through schooling for each unit increase in teacher salary (linked to credentials) they did not consider an increase beyond which the gains would diminish or cease to occur. However, it is clear that such a limit would most likely occur.

Therefore we still know virtually nothing about the critical lower or upper thresholds which set boundaries to rational and economic improvements in teacher selection and preparation. Clearly more research into this question is needed for rational planning in LDCs.

(2) Teaching Styles:

The effects of teaching style on student outcomes, both cognitive and non-cognitive, have been thoroughly researched in North America and the U.K. (see, for example, Gage, 1963, and Rosenshine, 1971). While in most instances teacher style, such as authoritarian or non-authoritarian methods, has been found to be important for certain kinds of students and in some subjects, few overall generalizations regarding this variable have been forthcoming.

Again, as with the previous discussion, none of the studies consulted for this report included direct measures of teacher style. Thus empirical evidence from LDCs regarding this aspect of teacher characteristics is simply not available.

However, there has been speculation and exhortation about appropriate and effective teacher styles for LDCs. For example Cole and Bruner (1975) argue that teachers of disadvantaged children would be more successful (in terms of student performance) if they "stop laboring under the impression that (they) must create new intellectual structures, and start concentrating on how to get the child to transfer skills he already possesses to the task at hand" (p. 121).

Nduka (1974), writing on needed educational reform in Nigeria, has argued that non-authoritarian teaching methods are necessary in African schools to create critical and open minds which are essential for learning the skills of mathematics and science. He feels that this orientation is essential to counteract the strong non-critical and "closed" cultural traditions of African thought patterns.

In both of the above examples, the authors assume that teaching styles influence learning outcomes. We must know more about this set of variables, specifically as they are appropriate for effective and efficient teaching in different societies and cultures.

(3) Alternative Programs for Teacher Training:

Teacher training, even in LDCs, generally follows a traditional western pattern and as such is conservative and expensive with respect to local needs and resources (Husén, 1977). It is legitimate, therefore to ask whether alternate programs might be possible and feasible, at least in some developing countries.

Implicitly, a number of alternate teacher training programs are suggested by studies in this report, for example the use of upgrading or inservice training schemes, especially for poorly trained teachers, and the retraining of teachers for new curricula (cf. III:10). Likewise, programmed teaching materials with relatively untrained personnel have also proven successful, at least in early grades and for some subjects, as well as the use of instructional television and radio (cf. III:12). Unfortunately none of the literature examined for this report provided clear evidence that these alternate strategies were either more efficient or less expensive than the use of conventionally trained teachers in face-to-face teaching situations (Carnoy and Levin, 1975).

It may be that a combination of alternative strategies might be useful in some situations. For example, Husén (1977) has recently suggested that teacher training should take place both in and outside of institutional settings. Pre-service training of short-term duration might be feasible for primary education and could provide a rapid and plentiful supply of teachers

at this expanding educational sector. As in Botswana and Tanzania, the source of these teachers could be in the form of national service programs for school leavers, at least temporarily (Husén, 1977; Mmarai, 1977). Formal teacher training colleges could then be reserved for those who had, on the basis of their primary teaching service, decided upon a teaching career, especially at the more advanced levels.

Whatever the alternate strategies, and they are many, it is necessary that experimental research be specifically designed to assess both their cost and effectiveness. Finally, alternate strategies should be chosen only after the social, cultural and demographic features of the country have been carefully considered. Otherwise alternate strategies could be detrimental in the long-run to the improvement of education in developing contexts where literate and trained manpower is needed.

(iv) Policy Recommendations

On the basis of the conclusions of the previous section, the following policy recommendations are suggested:

1. No program for teacher training and teacher allocation should be designed and initiated in LDCs without first acquiring a thorough knowledge of the demographic, structural, and cultural context within which the program is to function. These contextual factors should not be taken lightly, as they can considerably affect the success of even the best qualified and trained teachers. Furthermore, one cannot assume that all LDCs are alike with respect to educational processes. Differences between some LDCs may be greater than between LDCs and developed countries.

2. Efforts should be made to increase and improve teacher training programs in LDCs. Furthermore, short-term teacher upgrading programs would be effective for those teachers already in the profession but who have not had extensive training.

3. Selection and recruitment of teachers should be made with a knowledge of their most effective use, i.e., that male teachers will likely be more successful than females in teaching mathematics and science, and so forth. Naturally these allocations can only be made with the full knowledge of the cultural context within which they are made, especially the social roles and status of males and females, age groups, and the nature of the status structure.

4. A major focus of teacher training should be on the development of teacher knowledge and ability in specific subject areas.

5. Emphasis in teacher training programs should be on developing favorable teacher attitudes towards students. Furthermore, teacher trainees should be made aware of the impact of their expectations of students on subsequent performance.

6. Where programmed teaching and relatively untrained teachers are used, their use should be restricted to the early primary grades and for those subjects which have strong links with cultural and other outside agencies, for example reading.

7. Attention should be directed to the most productive use of experienced teachers, especially those with less training, by using them in the primary grades.

8. Further research should be undertaken in LDCs in the unique relationships between teacher and student, and their impacts on learning. Specific attention should be directed to the interactions between particular teacher variables, and how these variables relate to learning.

9. Research should be directed to the location of "threshold" effects of teacher competence variables, that is, at what point does additional training cease to be effective, and for what grade levels, subject areas, and so forth. Currently we have virtually no information on teacher competence "thresholds", and in the case of LDCs such information could have important financial and educational consequences.

(v) Suggested Design for Future Research

Following this review of 32 studies of teacher effects in LDCs, it is apparent that many gaps still exist in our knowledge and understanding of the learning process, and the role of the teacher in this process. Thus it is appropriate that this review end by volunteering suggestions as to the content and design a research project might take in order that some of these gaps be filled.

First, it should be realized that research on any one LDC cannot be readily extrapolated to another LDC, any more than research from developed countries can be extrapolated to LDCs. Thus the most ideal study would be one where several different "types" of countries are included, with exact replications for each country.

Secondly, it is clear that more studies of an experimental nature are desperately needed. Straightforward survey research has made a considerable contribution to our knowledge of education in all countries. However, in order to test specific hypotheses about teacher variables, and furthermore to avoid some of the pitfalls of achievement studies to date, accounting for student gains with pre-test and post-test results for experimental and control groups may add much to our present knowledge.

The characteristics of teachers should be linked with their students for the different cognitive outcomes. Analyses should be made at the between-student level rather than aggregated school or country levels.

Finally, close attention should be directed to the interrelationships between specific teacher variables, and possible interaction effects should be investigated.

It would be difficult to present more specific directives for possible research designs. The suggestions presented above derive from the body of research covered in this report, although any effective design would of necessity take into account the country, demographically and culturally, within which the study would take place.

Ultimately, future research should not be preoccupied with the question of whether trained teachers make a difference, since that question has already been answerd by cumulative research evidence. The question which remains unanswered is how, and because of what qualities and in what contexts do teachers make a difference. Answers to these questions will make significant contributions to our understanding of the teacher-learner process generally, and in LDCs, and will help improve schooling outcomes in a manner most congruent with LDC needs. Agencies involved in the financing of teacher training programs are in a unique position to promote experimental and controlled non-experimental studies on the effects of teacher training on student achievement. Such evaluation ought to be an integral part of any such financing effort as a way of assuring efficient use of development resources.

APPENDIX A

SOME PROBLEMS IN THE INTERPRETATION OF RESEARCH FINDINGS

As mentioned at the conclusion of Section I, the interpretation of school achievement studies in LDCs in the light of findings from developed countries is not always an easy task. Both in terms of the social and cultural context of schooling in LDCs, and the methodological procedures in many recent LDC studies, there are grounds for suspecting that the real relationship between teacher training characteristics and student performance is somewhat underestimated. Thus the conclusions of this literature review should be regarded as conservative statements about the probable gains to student achievement through the upgrading of teachers in LDCs.

In this appendix, two types of factors which might obscure real teacher effects are discussed: 1) factors related to the experience of schooling in LDCs, and 2) factors related to methodological procedures used in some LDC achievement studies.

A. The Educational Experience in Less Developed Countries

First it will be useful to raise some issues that relate to the assumed differences between developed and less developed countries in the educational experience of students. These issues might be crucial since they could affect the extent to which conventional theoretical and empirical models of educational processes can be used equally in developed and less developed societies in the analysis of education. They might also help to highlight possible differences in the expected roles and performance of teachers.

In most current educational research it is generally assumed that differences in educational processes (outcomes) represent differences of degree rather than kind. In other words, the reasons for the lower performance of students in LDCs (as documented in the IEA studies) are said to be less adequate physical facilities, poorly qualified and untrained teachers, and deficient pre-school and home environments. In support of this position, Simmons (1974) has argued that learning behavior "appears to share common mechanisms across cultures", and that the burden of proof rests with those who question this position.

Some evidence, however, calls into question certain assumptions about schooling outcomes in LDCs. These can be classified into three categories: 1) the effect of schooling on cognitive development, 2) cross-cultural differences in cognitive processes, and 3) differences in the school experience. Each of these will be briefly discussed.

(i) In LDCs, to what extent is schooling preferable to no schooling for the development of cognitive abilities?

Those who minimize the importance of school and teachers implicitly suggest that either the school is an unimportant agent for cognitive development, at least in some cultural contexts, and that to attempt to improve school efficiency by increasing school resources, such as teacher training, will produce negligible results.

A major obstacle in testing this proposition stems from the fact that it is virtually impossible to investigate the relative advantages of schooling since, in most societies, it is now difficult to find control groups who are unschooled. Nevertheless two studies have been located, that by Fahrmeier (1975) in Nigeria and Sharp and Cole (1974) in Mexico, which make recent contributions to the discussion.

With respect to Fahrmeier's study in particular, children between the ages of six to thirteen were tested for level of cognitive development and, as expected those who attended school showed higher level of ability than those who did not attend. However, an unexpected discovery was that the gap in ability between the schooled and the unschooled remained constant for each age group. In other words, at point of entry into the schools, those who did enter already manifested higher levels of cognitive development (the result of a selection process already apparent). Yet, through maturation and exposure to other agents of socialization and learning, the unschooled also developed intellectually. Thus given the original differences between the two groups, schooling bestowed little additional advantage in the acquisition of cognitive skills, nor were its effects cumulative.

By contrast, Sharp and Cole (1974), in their investigation of 446 individuals between the ages of 14 and 61+, and from both traditional and non-traditional Mexican towns, concluded that in spite of clear age effects, schooling exercised a "profound effect" on cognitive abilities.

What is suggested in these and similar studies is that in highly traditional societies there may be some intellectual development, at least regarding cultural learning, outside the school, through extended families, elders, rituals, and other means (Akinpelu, 1974). In contexts such as these, the effects of teachers will be partly obscured or even contradicted by these factors.

Unfortunately, not enough systematic and rigorous research has been conducted on the complex inter-relationship between the culture of society and the school, especially with respect to student achievement in LDC schools.

(ii) To what extent are cognitive processes of people from different cultures shared?

Another issue concerns the extent that cognitive styles differ between cultures. Those who maintain large differences say that cross-cultural comparisons of achievement on standardized tests, and even the use if standard statistical models in the analysis of achievement data, may be questionable.

For example Gladwin (1970), in his study of logical thinking among the Puluwat islanders in the South Pacific, argued that cognitive measurement instruments and other achievement tests are intended to measure the way information is categorized and organized, rather than the way it is processed and manipulated. Thus Gladwin contends that children from cultures other than the western middle-class are likely to perform less well on such tests, and by implication appear less competent. However he argues that they may be highly competent, but according to criteria not measured by conventional achievement instruments. Thus teachers may manifest different degrees of success depending on the subject taught and the cultural traditions of the students' environment.

This position is supported by the earlier research of Gay and Cole (1967) on the mathematics ability of members of the Kepelle tribe in Nigeria. After developing two sets of mathematics problems, one based on conventional tests, the other based on the cultural and environmental setting of the Kepelle, the researchers administered both sets to a sample of Africans and Americans. In both samples, individuals excelled on the problems appropriate to their culture and scored poorly on those derived from the other cultural context.

The implication here is that the interpretation of achievement scores and other outcome variables based on presumed standardized tests may, in fact, obscure the real link between teachers and student performances. Thus the comparison of these test scores across cultures is somewhat problematic, particularly in attempts to compare the importance of background and teacher effects in a given context with respect to given cognitive outcomes.

In contrast to the view which posits the "psychic unity of mankind" (and thus "shared" learning processes), an alternative position contends that differences in substantive knowledge and problem-solving abilities represent more profound and fundamental differences in logic and other thought processes. Gladwin (1970), for example, has argued that these processes are culture-bound.

> "There are already in existence numerous comparative studies of cognition in different cultures (Tyler, 1969). However, with but a few rare exceptions these have been concerned with the frameworks within which information is organized for use, frameworks which have been variously called cognitive maps, semantic frames, or ethnoscience. Yet the differences in cognition between middle-class and poor people in the United States seem to lie more in the way information is processed and manipulated than in the way in which it is categorized and organized. If this is true, the critical differences should be sought in styles of thinking, problem-solving, and planning." (Gladwin, 1970:218)

Thus both positions in this issue affect the interpretation of achievement study findings, particularly in LDCs. For example, in studies of test results, it is generally found that children in LDCs score lower than those in developed countries, and thus one might conclude either: 1) that by upgrading schools and teachers in LDCs, greater comparability in test scores might be obtained, or 2) that the differences are due to more fundamental cognitive processes and less amenable to policy intervention without radically changing the culture context.

Clearly whatever policy recommendations one makes will, to a large extent, depend on how one interprets or explains the differences in achievement results. There is much room for further investigation of this culture-cognition problem.

(iii) <u>To what extent is the experience of schooling comparable across cultures?</u>

This question concerns the continuity between school and culture, and whether there is harmony between school and other cultural agents, for example the family, religion, power structure, and the knowledge system. It has been observed that in some traditional cultures, especially those found in LDCs, this question may be important.

In the first place, it has been argued that in traditional societies much cultural (moral) education is likely to occur outside the school. It is often forgotten that the school is an innovation of western cultures, and in its present form, represents a western "import" into non-western environments. To this extent it has sometimes been found to lack relevance with respect to the cultural needs of the students who experience it, and may be poorly suited to the training of technological and scientific skills, the results are that standard teaching and learning processes may seem to produce minimal outcomes (Akinpelu, 1974; Leacock, 1972).

There are several reasons which might explain the lack of relevance of schools in some LDCs. To begin with, there is often little recognition of or knowledge about, the traditional educational processes. There can be little doubt that complex informal educational systems exist in many traditional societies, through which highly valued cultural knowledge is transmitted, such

as family members, religious leaders, village elders, and peers (Akinpelu, 1974). In many contexts, a teacher who is an "outsider" to the culture, using materials and techniques which are unfamiliar in a setting (the school) which is equally strange, can experience only limited success. As Akinpelu has observed, "... whereas the parents in western culture tend to 'thrust' out their children to others to train rather early, in the non-literate societies, the parents and the family assume greater responsibility in, and spend longer time on, the training of their children" (p. 418).

It should be noted, however, that in these traditional societies, the teacher is virtually the only source of most technical and scientific knowledge as few other persons in the immediate social and cultural context are likely to possess this kind of expertise. Thus the teacher's importance for the mastery of this knowledge cannot be overestimated. Yet schools in LDCs, particularly if the language of instruction is not the mother tongue, tend to teach more than technology and science; western cultural values are also imparted.

A second consideration thus concerns the potential conflict between the values of traditional societies and western education. This can be illustrated by pointing out the lack of relevance which sometimes exists in much of curriculum content in LDC schools. For example, Coleman (1972) has argued that one of the basic functions of the school is to provide the child with a vicarious experience of the adult world, including both social and interactional structures, and the physical world. Yet it has been observed that the content of subjects taught in some LDC schools lack this relevance. Books are frequently imported from western countries, and often are outdated castoffs (Leacock, 1972). The curriculum is oriented towards the successful completion of external examinations, which are set in former colonizing countries, and which often require the mastery of knowledge and skills which bear little relevance to the cultural context of the host society. Thus the vicarious experience of children in some LDC schools is of a society which is completely foreign to them, and which, for the most part, they will never experience.

B. Some Methodological Considerations

In addition to the above framework within which results of studies of student achievement in LDCs must be assessed, there are a number of methodological difficulties which must also be considered. While the following observations pertain equally to studies in developed and less developed societies, they are offered with particular reference to the studies which are reviewed in this report.

Most studies relevant for the analysis of teacher effects have used survey research designs and have focused upon students or schools as the units of analysis. 1/ The most common statistical operations have been based on OLS regression techniques, usually following analysis of variance strategies, either by increment in variance-explained procedures or disaggregation of variance-explained strategies. The initial model upon which many of these studies were built is from the original Coleman Report (1966), the criticisms of which are numerous and well-known (Bowles and Levin, 1968a, 1968b; Cain and Watts, 1970; Hanushek and Kain, 1972 - to name just a few).

The basic equation for most of these studies has been derived from the Education Production Function (EPF). In brief, the EPF focuses on the educational outputs of schools (usually in the form of achievement scores) as functions of various school inputs (usually the background of students, teacher characteristics, and other school facilities). The EPF model has been adequately described and criticized elsewhere, and these will not be repeated here (see, for example, Alexander and Simmons, 1975; Lueke and McGinn, 1975; and Brown, 1975). However a number of specific problems must be kept in mind when assessing the LDC studies of teacher characteristics and achievement.

(i) Aggregation of data

In virtually all studies of achievement, school and teacher variables have been aggregated at the school level, while student variables have been used at the individual level. Thus one assumes that school facilities and teachers have similar effects on all students, and that the allocation of inputs to students is independent of student characteristics.

However there has been considerable evidence to indicate that students do not receive equal benefits from schools and their teachers. The alternate strategies which at least partially overcome these difficulties are to link teacher and student in the analysis, or to use the teacher as the unit of analysis (for the study of teacher effects). These strategies, however, have been rarely utilized.

1/ The use of teachers as the unit of analysis is virtually unknown in teacher effect studies. Yet the advantage of this strategy should be obvious, since the aggregation of teacher variables (a normal procedure in EPF studies) masks rather than reveals the importance of teacher characteristics. A useful example of this alternate strategy is found in Veldman and Brophy's (1974) study of primary school teachers in a Southwestern U.S.A. school. They report a positive relationship between teacher quality and student achievement.

(ii) Substantive characteristics of populations in LDCs which have methodological implications

Closely linked with the technical aspects of research methodologies often employed in research into the determinants of student achievement are a number of substantive considerations. It is generally known that the outcomes of regression analysis are contingent to a large extent on the nature of the variables entered into the regression. The fact that teacher and school variables have not accounted for much variance in achievement outcomes in LDC studies is possibly due to little variation in these variables. Thus it appears that once a certain threshold level of school facilities and teacher quality has been reached, little additional effect on achievement can be obtained by the manipulation of these variables (Alexander and Simmons, 1975; Caillods, et al., 1975; Schiefelbein, 1975; Heyneman, 1976a).

However, in the study of LDC schools there is reason to believe that the variation in school resources, and in particular teacher competence, is much greater than in developed industrialized countries. Although little attention is generally given to these differences in most reports (except perhaps ex post facto), international studies of educational achievement have documented these differences at an international level (Coleman, 1975; Platt 1975). Thus any differences either in achievement, and certainly in the relative importance of its determinants such as school resources or teacher competencies, may be a function of wider variations between schools (or regions) of these variables. With this in mind, the following observations are useful in the estimation of teacher effects from LDC achievement studies.

1. The variation of socio-economic background of students in many LDCs is greatly attenuated, with the result that background appears to contribute little in explaining variance in achievement (Heyneman, 1976a). Compared with developed countries, where there is considerable heterogeneity in material conditions, life-styles, and occupational status, the background conditions of LDCs is relatively homogeneous. 2/

2. Concommitant with the above, there is often in most LDCs a wider variation in teacher related variables than is found in developed industrialized countries, thus making it statistically possible to find a stronger teacher effects in the LDCs. The fact that this has not sometimes been the case (see, for example, Heyneman, 1976b) lends even greater support for the unimportance of these variables in explaining variance in student achievement.

2/ An example of this situation can be found in the recent Botswana survey, which showed that 50.3 percent of the Form III students came from agricultural backgrounds, and that 71.9 percent of the fathers owned cattle (Husen, 1977, Pop. II, 1976). Heyneman (1976a) describes his efforts to maximize background variation in his Uganda study in order to more accurately measure their effects on achievement outcomes.

3. Studies in industrialized countries have shown that school and teacher resources have differential effect on students of varying abilities and backgrounds: the more disadvantaged the students, the greater effect of school and teacher variables. Insofar as there is a large proportion of students in LDCs from deprived backgrounds, one would expect that resource variables would have greater impact on achievement than studies in industrialized countries would tend to suggest.

In addition to the previous methodological considerations, there are a number of specific problems concerned with the use of survey data and highly sophisticated multiple regression procedures which may tend to underestimate teacher effects. These are briefly summarized below.

(i) Assumptions underlying the use of survey data and the EPF in studies of achievement in LDCs

1. In order to infer causality from cross-sectional data (i.e. survey data), it is necessary to assume that some variables precede others in time, and that present levels of a variable are reliable indicators of past levels (for example, student background variables, which may or may not be cumulative over time).

However, this assumption is incongruent with the fact that students may encounter many teachers during their academic careers, and that the mobility between schools of teachers and students introduces error into the input variable measurements. The possibility of significant relationships between input and output variables is reduced. 3/

2. In previous analyses of the factors relating to student achievement, researchers have generally assumed that the learning process is a constant, and thus have generated a single explanatory equation to describe the relationships between input and output variables.

However, as already established in this report (IIA), this assumption is incongruent with considerable evidence from anthropologists and psychologists. It has furthermore been questioned by other evaluators of the research literature (Averch, et al., 1972), as well as persuasive argumentation based on conditions in LDCs (Schiefelbein, 1975).

(ii) Assumptions underlying multiple regression and variance explained strategies

In a recent survey of research on student achievement in LDCs (Alexander and Simmons, 1975), attention is limited to EPF studies using multiple regression techniques. Not only have most of the larger and more

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3/ The turnover of teachers in LDC schools has been frequently mentioned. See, for example, Watson-Franke (1974) and Schiefelbein (1975).

sophisticated studies utilized these techniques, but these statistical strategies have generally been considered more valid and productive than other known types of strategies. With this in mind, the following observations are presented as useful guidelines in asessing these types of studies, especially when the analysis of determinants of student outcomes produce small or insignificant results. 4/

1. If only a few variables are used in the student achievement models, the amount of total variance explained will be small.

2. If the model used in the analysis is misspecified, and the independent variables in the equation are unimportant, then obviously the total amount of variance explained will be small or insignificant.

3. If there is considerable multi-collinearity among the variables which are presumed to explain achievement differences, then the total amount of variance explained will be small or insignificant.

4. Likewise, if there is considerable measurement error in the variables in the model, the total amount of variance explained will be reduced or underestimated. This observation is particularly important in the assessment of the validity and reliability of achievement measures, as well as attitudes of teachers and students and other aspects of teacher and student behavior.

5. If there is little variance in the variables, then there will be little to explain, even in highly sophisticated models. Thus if the parents of all the students in a particular sample come from similar backgrounds, little of the variance will be explained by this factor. Clearly this is an important consideration when assessing studies of achievement in LDCs.

6. When incremental partitioning of variance is the strategy used, (as has been the case in most achievement studies), and when the variables in the model are intercorrelated (which they usually are), the importance of each variable, or block of variables, is largely determined by the order of entry into the regression equation.

4/ A most useful summary of possible explanations for small or insignificant variance explained (R^2) by factors in achievement models, is found in Pedhazur.

APPENDIX B

THE SEARCH STRATEGY

Although the Teacher Training Project officially began in late January, 1977, work was already well in progress in mid-December 1976. An ERIC search was commissioned in late January after a careful selection of over 30 descriptors. This search resulted in the identification of 1463 items related to teacher variables, student achievement, and LDCs. While much of this material related to background or topics of central concern to the project, a number of key articles and reports were identified in this manner.

During this time a systematic bibliographic search was being conducted through other information retrieval sources. In particular searches were conducted in Current Contents, Psychological Abstracts, Sociology of Education Abstracts, and Sociological Abstracts.

From March 16 to March 22, Saha visited the International Institute for Educational Planning (IIEP) in Paris, not only to utilize their library facilities in educational planning and development, but also to consult with members of the staff.

From May 9 to May 20 a second project mission was made. Included were searches of the library holdings of the International Bureau of Education (IBE) and the International Labor Organization (ILO) in Geneva. A second visit to IIEP in Paris permitted the completion of the search, which began earlier. The search also included the resources of the Institute of Education at the University of London and the Institute of Development Studies (IDS) at the University of Sussex. At all these institutions, interviews were held with key personnel, and their libraries and other resources were utilized in order to locate additional materials which might be relevant to the topic of the project.

From February to June, three work-in progress seminars were given at the Institute for International Education, Stockholm: February 24, April 14, and June 7. Many of the ideas relevant to this report were articulated and debated by members of the Institute staff, whose contributions must be acknowledged.

During the remainder of June, and throughout July and August, the results of the search were organized, thoroughly examined and written up, terminating in the present report.

BIBLIOGRAPHY

A. Studies Concerned With Teacher Characteristics and Achievement in Less Developed Countries

BEEBOUT, Harold Seymour, The Production Surface for Academic Achievement: An Economic Study of Malaysian Schools. PhD. Thesis, University of Wisconsin, 1972.

BIBBY, John and Margaret PEIL, "Secondary Education in Ghana: Private Enterprise and Social Selection", Sociology of Education, 47 (Summer 1974): 399-418.

CARNOY, Martin, "Family Background, School Inputs and Student's Performance in School: The Case of Puerto Rico", Stanford University, School of Education, 1971.

_____, "A Systems Approach to Evaluating Education, Illustrated with Puerto Rican Data", Stanford School of Education, 1971a.

CARROLL, J.B., The Teaching of French as a Foreign Language in Eight Countries, Stockholm: Almqvist & Wiksell, 1975.

COMBER, L.C., and John P. KEEVES, Science Education in Nineteen Countries, Stockholm: Almqvist & Wiksell, 1973.

CURRIE, Janice, "Family Background, Academic Achievement and Occupational Status in Uganda", Comparative Education Review, 21 (February 1977): 14-28.

DUROJAIYE, M.O.A., "The Role of Non-Cognitive Factors in School Learning of Uganda Secondary School Pupils", West African Journal of Educational and Vocational Measurement, 2 (1) (December 1974): 35-39.

ELLSON, Douglas G., Programmed Teaching: Effective Teaching by "Unqualified Teachers", Innotech: Regional Center for Regional Innovation and Technology, June 1973.

FARRELL, J.P., and E. SCHIEFELBEIN, "Expanding the Scope of Educational Planning: The Experience of Chile", Interchange, 5 (1974): 18-30.

FULLER, William P., and Amrung CHANTAVANICH, A Study of Primary Schooling in Thailand: The Final Report: Factors Affecting Scholastic Achievement of the Primary School Pupils. Thailand: Office of the National Education Commission, 1976.

BIBLIOGRAPHY (Continued)

HEYNEMAN, Stephen P., "Influences on Academic Achievement: A Comparison of Results from Uganda and More Industrialized Societies", Sociology of Education 49 (July 1976a): 200-211.

_____, "Relations Between Teachers' Characteristics and Differences in Academic Achievement Among Ugandan Primary Schools", Education in Eastern Africa, 6 (1976b): 41-51.

HORNIK, Robert C., et al., Television and Educational Reform in El Salvador: Final Report, Stanford University: Institute for Communication Research, 1973.

HORNIK, Robert C., "Television, Background Characteristics and Learning in El Salvador's Educational Reform", Instructional Science, 4 (1975): 293-302.

HUSÉN, Torsten, "Pupils, Teachers and Schools in Botswana -- A National Evaluative Survey of the Primary and Secondary Education", Annex A of Education for Kagisono. Report of the National Commission on Education in Botswana, Gaborone: Government Printing Office, 1977.

IZQUIERDO, Por Carlos Munoz, and Jose Teodulo GUZMAN, "Una exploracion de los factores determinantes del edimento escolar en la educacion primaria" (An exploration of the determining factors of school output in primary education). Revista del Centro de Estudios Educativos, 1 (2) (April 1971): 7-27.

KLEES, Stephen J., "Television and Other Determinants of Scholastic Achievement in Mexican Secondary Education". Paper prepared for the American Education Research Association Conference. Stanford University: Institute for Communication Research, April 1974.

LEWIS, E. Glyn, and Carolyn E. MASSAD, The Teaching of English as a Foreign Language in Ten Countries. Stockholm: Almqvist & Wiksell, 1975.

LEVY, Mildred B., "Determinants of Primary School Dropouts in Developing Countries", Comparative Education Review, XV (1) (February 1971): 44-58.

NASOETION, N., A. DJALIL, I. MUSA, and S. SOELISTYO, The Development of Education Evaluation Models in Indonesia, Paris: International Institute for Educational Planning, (UNESCO), 1976.

BIBLIOGRAPHY (Continued)

OKUNROTIFA, P.O., "A Pilot Study of Nigerian Pupils' Attitude Toward and Achievement in a Programmed Unit of Geography", Journal of Negro Education, 44 (4) (1975): 538-546.

PHILIPPINES DEPARTMENT OF EDUCATION AND CULTURE, Survey of Outcomes of Elementary Education, Makati, Rizal Philippines, May 1976.

PURVES, Alan C., Literature Education in Ten Countries. Stockholm: Almqvist & Wiksell, 1973.

ROWE, Elizabeth, Y.P. LAU, G.H. LEE, A.K. LI, and W.G. RODD, Failure in School: Aspects of the Problem in Hong Kong. Hong Kong University Press, 1966.

RYAN, John, Educational Resources and Scholastic Outcomes: A Study of Rural Primary Schooling in Iran. Stanford University, PhD. Thesis, 1972.

SCHMELKES, Sylvia, "Estudio de Evaluacion Aproximitiva de las Escuelas Radiofonicas de la Tarahumara (Mexico)", Revista del Centro de Estudios Educativos, 2 (1972): 11-36.

SHUKLA, Snehlata, "Achievements of Indian Children in Mother Tongue (Hindi) and Science", Comparative Education Review, (June 1974): 237-247.

SILVEY, Jonathan, "Long-Range Prediction of Educability and Its Determinants in East Africa", in L.J. Cronback and P.J.D. Drenth, (eds), Mental Tests and Cultural Deprivation, Paris: Mouton Publishers, 1972.

SOMERSET, H.C.A., Predicting Success in School Certificate: A Uganda Case Study. Nairobi: East Africa Publishing House, 1968.

THIAS, Hans Heinrich and Martin CARNOY, Cost-Benefit Analysis in Education: A Case Study of Kenya. Washington, D.C., International Bank for Reconstruction and Development, 1972.

THORNDIKE, Robert L., Reading Comprehension Education in Fifteen Countries. Stockholm: Almqvist & Wiksell, 1973.

WILLIAMS, T. David, "Wastage Rates and Teaching Quality in Guatemala Primary Schools", Comparative Education Review, 11 (February 1965): 46-53.

BIBLIOGRAPHY (Continued)

WINDHAM, Gerald O., "Occupational Aspirations of Secondary School Students in Sierra Leone", Rural Sociology, 35 (1) (1970): 40-53.

YOUDI, Robert V., An Exploratory Study of Achievement and Attitudes of High School Students in the Congo: An Aspect of Socialization for National Development. PhD. Thesis, Stanford University, 1972.

BIBLIOGRAPHY (Continued)

B. General Bibliography

AKINPELU, J.A., "The Educative Processes in Non-Literate Societies: An Essay in the Anthropological Foundations of Education", West African Journal of Education (1974): 413-422.

ALEXANDER, Leigh, and John SIMMONS, The Determinants of School Achievement in Developing Countries: The Educational Production Function, International Bank for Reconstruction and Development, Staff Working Paper 201, March 1975.

AVERCH, Harvey A., Stephen CARROLL, Theodore S. DONALDSON, Herbert J. KIESLING, and John PINCUS, How Effective is Schooling? A Critical Review and Synthesis of Research Findings, Santa Monica, Calif.: Rand Corp., 1972.

AYABE, Tsuneo (ed), Education and Culture in a Thai Rural Village, The Research Institute of Comparative Education and Culture, Faculty of Education, Kyushu University, Fukuoka, Japan, February 1973.

BOWLES, Samuel, and Henry M. LEVINE, "The Determinants of Scholastic Achievement - An Appraisal of Some Recent Evidence", Journal of Human Resources, 3 (Winter 1968): 3-24.

_____, "More on Multicollinearity and the Effectiveness of Schools", Journal of Human Resources, 3 (Summer 1968): 393-400.

BROWN, Daniel J., "Down with the Linear Model", American Educational Research Journal, 12 (Fall 1975): 491-505.

CAIN, Glen G., and Harold W. WATTS, "Problems in Making Policy Inferences from the Coleman Report", American Sociological Review, 35 (April 1970): 228-242.

CARNOY, Martin, and Henry LEVIN, "Evaluation of Educational Media: Some Issues", Instructional Science, 4 (1975): 385-406.

CHARTERS, W.W., "The Social Background of Teaching", in N. Gage (ed), Handbook of Research on Teaching, Rand McNally & Co.: Chicago, 1963: 715-813.

BIBLIOGRAPHY (Continued)

CHOPRA, S.L., "Parental Occupation and Academic Achievement of High School Students in India", Journal of Educational Research, 60 (1966-1967): 359-362.

CALLIODS, F., G. CARRON and C. TA NGOC, "Research Project on Regional Disparities in Educational Development", Paris: IIEP/UNESCO, 1975 (mimeo).

COLE, Michael and Jerome S. Bruner, "Cultural Differences and Inferences about Psychological Processes", in Martin L. Maehr and William M. Stallings (eds), Culture, Child and School, Monterey, Cal.: Brooks/Cole Publishing Company, 1975.

COLEMAN, James S., et al., Equality of Educational Opportunity. Washington, D.C.: U.S. Government Printing Office, 1966.

COLEMAN, James S., "The Children Have Outgrown the Schools", Psychology Today, 5 (9) (February 1972): 72.

_____, "Methods and Results in the IEA Studies of Effects of School and Learning", Review of Educational Research, 45 (3) (Summer 1975): 335-386.

CURRIE, Janice, "Stratification in Uganda: Schooling and Elite Recruitment", Greylands Educational News, 9 (July 1974): 26-42.

DRYSDALE, Robert S., "Factores Determinantes de la Desercion Escolar en Columbia", Revista del Centro de Estudios Educativos, II (1972): 11-36.

DUNKIN, Michael J., and Bruce J. BIDDLE, The Study of Teaching, New York: Holt, Rinehard and Winston, Inc., 1974.

EPSTEIN, Erwin H., "Parasitic diseases and academic performance of school children", Social and Economic Studies, 23 (4) (1974): 551-570.

FAHRMEIER, Edward D., "The Effect of School Attendance on Intellectural Development in Northern Nigeria", Child Development, 46 (1) (1975): 281-285.

GARCIA, Carmen, Eduardo CASTENADA, Lilian de Leon, and Ernesto SCHIEFELBEIN, "Television y Redimento Escolar en Venezuela" (Television and School Outputs in Venezuela), Revista del Centro de Estudios Educativos, IV (1) (1974): 43-52.

BIBLIOGRAPHY (Continued)

GAY, John and Michael COLE, The New Mathematics and an Old Culture: A Study of Learning Among the Kepelle of Liberia. New York: Holt, Rinehard and Winston, Inc., 1967.

GETZELS, J.W., and P.W. JACKSON, "The Teacher's Personality and Characteristics", in N. Gage (ed), Handbook of Research on Teaching. Chicago: Rand McNally & Company, 1963.

GLADWIN, Thomas, East is a Big Bird: Navigation and Logic on Puluwat Atoll. Cambridge: Harvard University Press, 1970.

GUTHRIE, James W., "A Survey of School Effectiveness Studies", in Do Teachers Make a Difference? Washington, D.C.: Department of Health, Education and Welfare, 1970.

HANUSHEK, Eric A., and John F. KAIN, "On the Value of Equality of Educational Opportunity as a guide to public policy", in Frederik Mosteller and Daniel P. Moynihan (eds), On Equality of Educational Opportunity. New York: Random House, 1972.

HEYNEMAN, Stephen P., "Why Impoverished Children do Well in Ugandan Schools: The Difference Between Economic Privilege and Social Class": Mimeo (no date).

HUSÉN, Torsten (ed), International Study of Achievement in Mathematics: A Comparison of Twelve Countries (Vols. I and II). Stockholm: Almqvist & Wiksell, 1967.

HUSÉN, T., "Patterns and Structures for Teacher Education in Developing Countries". Invited Lecture at the London University Institute of Education, November, 1977.

INTERNATIONAL BANK FOR RECONSTRUCTION AND DEVELOPMENT, Education: Sector Working Paper. Washington: 1974.

JENCKS, Christopher S., and Marsha D. Brown, "Effects of High Schools on their Students", Harvard Educational Review, 45 (3) (August 1975): 273-324.

JENCKS, Christopher, et al., Inequality: A Reassessment of the Effect of Family and Schooling in America. New York: Basic Books, Inc., 1972.

BIBLIOGRAPHY (Continued)

KIROS, Fassil G., Selma J. MUSHKIN, and Bradley B. BILLINGS, Educational Outcome Measurement in Developing Countries. Washington, D.C.: Public Services Laboratory, 1975.

LAVIN, David E., The Prediction of Academic Performance. New York: Russell Sage Foundation, 1965.

LEACOCK, ELeanor Burke, Primary Schooling in Zambia: Final Report. Brooklyn Polytechnic Institute, 1972.

LUECKE, Daniel F., and Noel F. McGINN, "Regression Analyses and Educational Production Functions: Can They be Trusted?", Harvard Educational Review, 45 (3) (August 1975): 325-350.

LYNCH, Patrick D., "School and Family Predictors of Achievement and Dropout in Elementary Schools of a Developing Country", American Education Research Association Conference, Washington, D.C., 1975.

MAYO, Judith A., Teacher Observation in El Salvador, Washington, D.C.: Information Center on Instructional Technology, Academy for Social Development, 1971.

_____, Teacher Observation in Mexico. Washington, D.C.: Information Center on Instructional Technology, Academy for Social Development, 1973.

MMARI, G.R.V., "Attempts to Link School with Work: The Tanzanian Experience", Prospects, Vol VII(3) (1977): 379-388.

MORRISON, A., and D. McINTYRE, Teachers and Teaching. Penguin Books, Harmondworth, 1969.

NDUKA, O. "African Traditional Systems of Thought and Their Implications for Nigerian Education". West African Journal of Education, Vol. XVIIII (2) (June 1974): 153-164.

NOLLEN, Stanley D., "The Economics of Education: Research Results and Needs", Teacher's College Record, 77 (1), (September 1975): 51-77.

PEDHAZUR, Elazar J., "Analytic Methods in Studies of Educational Effects", in Fred N. Kerlinger (ed), Review of Research in Education: 3, Itasca, Ill.,: F.E. Peacock Publishing Co., 1975.

PLATT, William J., "Policy-Making and International Studies in Educational Evaluation", in Alan C. Purves and Daniel U. Levine (eds), Educational Policy and International Assessment. Berkeley: McCutchan Publishing Corporation, 1975.

BIBLIOGRAPHY (Continued)

ROSENSHINE, Barak, Teaching Behaviors and Student Achievement. London: National Foundation of Educational Research, 1971.

SCHIEFELBEIN, Ernesto, "The Impact of Input-Output Educational Research on Developing Countries", in John Simmons (ed), Investment in Education: National Strategy Options for Developing Countries. IBRD Working Paper 196, February, 1975.

SIMMONS, John, Towards an Evaluation of Literacy and Adult Education for Development: The Tunisian Experience. USAID/Tunis and UNESCO/Paris, April 1972.

_____, Towards an Evaluation of Literacy and Adult Education in a Developing Country: A Pilot Study. Department of Economics and Graduate School of Education, Harvard University, September 1970.

_____, "Education, Poverty and Development", in John Simmons (ed), Investment in Education: National Strategy Options for Developing Countries. IBRD Working Paper No. 196, February 1975.

SHARP, Donald W., and Michael COLE, The Influence of Educational Experience on the Development of Cognitive Skills as Measured in Formal Tests and Experiments: A Case Study from the Mexican States of Yucatan and Quintana Roo: Final Report. New York: Department of Health, Education and Welfare, 1974.

STUDSTILL, John D., "Why Students Fail in Masomo, Zaire", Journal of Research and Development in Education, 9 (4) (Summer 1976): 124-137.

VELDMAN, Donald J., and Jere BROPHY, "Measuring Teacher Effects on Pupil Achievement", Journal of Educational Psychology, 66 (3) (1974): 319-324.

WATSON-FRANK, Maria-Barbara, "Traditional Educational Concepts in the Modern World: the Case of the Guajiro Indians of Venezuela", Sociologus, 24 (2) (1974): 97-116.

WEIGHTMAN, George, and Zahi RIHANI, "Social Stratification and Adolescent Achievement in a Lebanese Town", Comparative Education Review (June 1967): 208-216.

PART II

AN EMPIRICAL STUDY OF TWO COUNTRIES: CHILE AND INDIA

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SUMMARY

The purpose of the present study was to investigate the effect of teacher training on student science achievement in developing countries. The data used were collected by the International Association for the Evaluation of Educational Achievement (IEA) in their 1970 survey. The countries involved in the present study were Chile and India.

The IEA data files contain a large number of items. Previous analyses, however, have used only a very small proportion of them. Attempts to analyze large school survey data sets in the late 1960's and early 1970's showed that a new paradigm was needed for thinking about and analyzing school and teacher effects on student outcomes of schooling. First, there was a need for methods for reducing the mass of data available to a small set of parsimonious descriptions of the relevant underlying phenomena. Second, there was a need for a causal conceptualization of the educational situation in models elaborate enough to cover all major relevant aspects of schooling. Third, there was a need for methods suitable for testing these models. Statistical developments in the 1970's have made great progress toward meeting these needs. A key development is the use of path modelling with latent variables, a technique used in the present study.

In investigating the effects of teacher training on student achievement, it was necessary to control for other relevant variables. This was done with the help of a model of the schooling situation, which covered, within the limits of the IEA data bank, as wide a scope as possible. The analytical methods used enabled the calculation of both the direct effect of formal teacher training, holding all other relevant variables constant, and the indirect effect, through other variables that teacher training influences. In addition, it was possible to calculate rough estimates of the potential effect of any form of teacher training.

The analysis showed similar results in Chile and India. Verbal IQ, of course, showed by far the strongest total effect on student achievement. The next strongest effect was shown by Teaching Methods. Teacher Training showed slightly stronger effects than Home Background. Sex of Student and Sex of Teacher had negative effects, with girls having lower achievement levels than boys and women teachers being associated with lower achievement levels among students than men teachers. Region and School Atmosphere had essentially no effect. The effects of other variables were inconsistent.

The results of the analysis suggest that if the mean level of formal teacher training in the respective countries were raised to the level of the most highly trained 50 percent of teachers today, mean student science achievement, as measured by the IEA test score, would rise from 9.6 to 10.3 in Chile and from 8.3 to 8.7 in India. These increases represent 8 and 5 percent of a standard deviation in achievement in the respective countries. These estimates are based on the assumption that increases in the level of teacher training would occur within the framework of the formal teacher training programs through which the sampled teachers had gone.

It might be argued, however, that the Teacher Training variable was too conservative a measure of the potential teacher effect, since it measured traditional formal teacher training. What is more important is not teacher training as such but the behaviors teachers manifest in the classroom. There are many ways that teacher behaviors can be changed, and formal training of young teacher candidates is only one way. Moreover, even other teacher variables, such as sex and experience, are really surrogates for teacher classroom behavior measures, since behaviors are not rigidly bound to sex or experience. Women teachers can, in principle, learn those behaviors which their male colleagues exhibit which account for the observed effects of teacher sex. From that point of view, an estimate of the potential effects of all forms of teacher training would be the combined effects of all teacher background and training variables, teaching methods, and a residual "Opportunity to Learn" variable. Approximate calculations of this aggregate teacher effect suggest that if aggregate teacher effectiveness were raised so that the mean teacher effectiveness were as high as the mean of today's most effective 50 percent of all teachers, student science achievement would rise from 9.6 to 11.0 in Chile and from 8.3 to 9.6 in India. These increases correspond to 16 and 15 percent of a standard deviation in achievement in the respective countries. The aggregate effect of school variables was approximately the same as the aggregate teacher effects.

The estimates of teacher effects on student science achievement calculated in the present study do not provide evidence on what economic rate of return countries might gain on investments in teacher training programs. That depends on a variety of pedagogical and economic considerations. What they do suggest, however, is that if investments are made in teacher training programs, there will be a return on the investment in terms of increases in the level of student cognitive outcomes of schooling.

INTRODUCTION

The present study is based on a reanalysis of the data collected by the International Association for the Evaluation of Educational Achievement (IEA) in their 1970 Science survey (Comber and Keeves, 1973). The analysis reported there consisted of stepwise multiple regression with fixed order of entry of blocks. There were four blocks, representing Home and Student Background, Type of School or Course, Learning Conditions in the School, and Kindred Variables. The analogical model on which the analysis was based is reported in detail in a technical report (Peaker, 1975). Neither the model nor the statistical methods used was adequate to enable a consideration of such specific questions as the effect of teacher training on student achievement. In the present study a more elaborate model is presented and more advanced statistical methods are employed. In the main part of the report the technical details are kept to a minimum. For a more thorough discussion of the technical aspects of the study the reader is referred to Annex B.

THE SAMPLES

In the IEA Studies, stratified probability samples of schools were drawn, and random samples of approximately 25 students were drawn in each of the selected schools. All teachers teaching science in the sampled schools were surveyed. Three populations were sampled. Loosely defined, these were the 10-year-old age group, the 14-year-old age group, and students in the terminal secondary school grade. In the present study, the 14-year-old age group, Population II, was analyzed. This decision was conditioned by the fact that at the 10-year-old age level, science is usually not taught as a separated and distinct subject. Teachers at that level are not expected to have specialized competence in science. At the terminal secondary grade level, however, the population consists of a very selected group of students, since most children in the relevant age groups had left school earlier. Also, students at that age have a wide range of specializations within science and among other fields. Subsampling science specialists from the total IEA sample, which would probably be necessary for a study of this kind, would seriously reduce the case base. The advantages with Population II are that relatively large proportions of children in the relevant ages are still in school and that all students are intended to acquire some degree of mastery of the unspecialized body of knowledge taught at that level.

Population definitions varied from country. The major differences concerned the definitions of the excluded populations. The design target population in Chile included students aged 14:00 - 14:11 who were in primary or secondary school above the fourth grade. Excluded were students in grades 1 - 4 (18.6 percent of the age group who were in school) plus 42.7 percent of the age group who were not in school. The design target population in India included students aged 14:00 - 14:11 who were above the fifth grade. Excluded were students in private institutions, schools where the medium of instruction was other than Hindi, schools for the physically handicapped, and vocational schools.

Geographically, the Chilean sample was nationally representative. The Indian sample, however, was restricted to the Hindi-speaking region, consisting of the states of Uttar Pradesh, Bihar, Madhya Pradesh, Rajastan, Haryana, and the Union Territory of Delhi. Approximately 41 percent of the total population of the country resides in this area.

The actual target population did not completely correspond to the design target population, as can be observed from the characteristics of the samples shown in Tables 1 and 2. The original files contain somewhat larger numbers of cases, but for the present study the files were edited by excluding students who, on the basis of test scores, could be defined as illiterate and thus probably unable to properly fill in the questionnaires. The definition of illiterate was generous, and a student had to have at least three test scores (Word Knowledge, Science, Reading Comprehension, or, in Chile, Literature) of less than or equal to zero in order to be removed from the sample. In addition, students not having a score for science were removed. Altogether 109 students were removed from the Chilean sample, and 225 were removed from the Indian sample.

Table 1: FREQUENCY DISTRIBUTION FOR AGE IN THE EDITED SAMPLES

Country	Age in Months										
	-161	162-164	165-167	168-170	171-173	174-176	177-179	180-182	183-185	186+	MD
Chile	0	1	0	347	249	253	226	97	0	0	77
India	453	127	67	465	405	434	267	249	82	129	82

Table 2: FREQUENCY DISTRIBUTION FOR GRADE IN THE EDITED SAMPLES

Country	Grade										
	3	4	5	6	7	8	9	10	11	12	MD*
Chile	2	16	121	183	165	356	283	53	1	1	69
India	5	10	21	355	737	1002	357	166	38	1	68

Note: * Missing data.

The total numbers of students, teachers, and schools included in the edited samples appear in Table 3. The figures shown for schools represent the actual number of schools in the sample. For the teachers, however, the figures represent only an approximation. Due to the aggregation process used in constructing the original between-student files, the exact number of teachers represented in the files is unknown.

Table 3: STUDENTS, TEACHERS AND SCHOOLS IN THE EDITED SAMPLES

Country	Students	Teachers	Schools
Chile	1250	302	147
India	2760	151	156

The student was the unit of analysis for the present study. With each student was associated responses to the school questionnaire as well as the school mean response for all teachers in the school. That is, individual students cannot be associated with individual teachers but with an aggregated "school mean" teacher. It should be noted that it has never been possible, at any stage in the construction and processing of the IEA data files, to link individual students and teachers. This, in turn, introduces a source of measurement error into the analysis, which leads to an underestimate of the effect of teachers on student achievement.

THE STATISTICAL METHODS

From Analogical Models to Causal Path Models with Latent Variables

In the international report of the IEA Science study, the analysis was based on an analogical model "corresponding to stages in the life of a student, who before he comes under survey has been conceived, born, brought up by his parents in a certain neighborhood, and undergoes early school education" (Comber and Keeves, 1973, pp. 189-190). In accordance with this model, the variables entered into the analysis were divided into four blocks, corresponding to the Home and Student Background, Type of School or Program, Learning Conditions in the School, and so-called "Kindred Variables". The blocks were entered in the given order into a multiple regression, and the increment in R^2 as each block was entered was taken as a measure of the "contribution" of the respective block. Such a procedure, however, is inevitably asymmetrical when the blocks are correlated (Coleman, 1975). This is very often the case in school survey research, where home and school circumstances are usually correlated (Noonan, 1976). Moreover, as Duncan (1975, p. 65) points out, partitioning of R^2 into parts attributed to different blocks "bears no essential relationship to estimating or testing a model, and it really does not add anything to our understanding of how a model works." Finally, a four-block model is too coarse for a study of specific educational problems, such as the effects of teacher training on educational achievement.

Under the circumstances, it is clear that a new paradigm was needed for thinking about school effects and for analyzing school survey data. First, there was a need for methods for reducing the mass of data available to a small set of parsimonious descriptions of the relevant underlying phenomena. Second, there was a need for a causal conceptualization of the educational situation in models elaborate enough to cover all major relevant aspects of schooling. Third, there was a need for methods suitable for testing these models.

In school survey research there are two key lines of development which move toward meeting the needs discussed above. The first of these is the use of path modelling, developed in biology in the late 1920's and early 1930's (Wright, 1934) and beginning to appear in the school survey literature in the late 1960's. The second is the use of latent variables, introduced in sociology in the 1950's (Lazarsfeld, 1959) and beginning to appear in school survey research in the early 1970's. A seminar paper based on ad hoc procedures but traceable to these two traditions appeared first at an IEA seminar and was later published (Coleman, 1975). More formal methods have also been developed, involving both ordinary least squares (Wold, 1973, 1976) and maximum-likelihood (Joreskog, 1973, 1976) regression procedures. These two methods have provided the necessary formalization of simultaneous data reduction procedures and estimation procedures within a framework of causal

path modelling. The ordinary least squares methods, NIPALS (Nonlinear Iterative Partial Least Squares), appear to be especially suited to the kind of macro models used in school survey research. Examples of the application of NIPALS methods to school survey data have been published (Noonan, 1977; Noonan and Wold, 1977).

These methods, by requiring the explicit specification of the latent variables, invite the formation of variables which are both conceptually and empirically satisfying. At the same time the analysis procedures, by requiring the explicit specification of a model, invite the development of a model that can be meaningfully interpreted in terms of educational theory. The result is the needed theoretically meaningful parameters relating the explicitly specified measures of the relevant underlying phenomena. The parameters used to assess the influence of the respective underlying phenomena are thus not increments in R^2 but standardized partial regression coefficients, or beta weights, which have exactly the same interpretation as in classical regression analysis.

NIPALS Path Modelling With Latent Variables

In attempting to analyze school survey data, one of the basic problems with which the researcher is faced is how to estimate the dependence of a criterion, Y, on a set of explanatory variables, X_j, which are correlated among themselves. In practice, one aspect of this problem is that generally the X_j's cannot be measured directly by a single questionnaire item. Instead they are measured by combinations of questionnaire items, x_{jk}. The underlying unobservables, X_j, are referred to below as latent variables when they are specified as linear combinations of observables, x_{jk}, which are referred to as manifest variables.

For example, in an analysis of the effects of teacher training on student achievement, it is necessary for student's home background and other relevant variables to appear in the model in order to provide unbiased estimates of the independent effects of teacher training, ceteris paribus. There is, however, no single item on any questionnaire which is adequate to represent the several dimensions of student home background. Instead there are from the IEA questionnaire for Chile twelve items directed at different aspects of the home background, as shown in Table 4. Using NIPALS methods, these items constitute twelve manifest variables. These variables are first standardized to zero mean and unit variance. Subsequently, latent variables are specified as linear compounds of the standardized manifest variables. These linear compounds, or weighted means of questionnaire items, are taken as more accurate measures of given dimensions of the home than any single item would be. Some variables, however, can be measured adequately by a single variable, such as Verbal IQ or Science Score. Although both are really compounds of items on tests, we will not distinguish between manifest and latent variable in such cases.

Table 4: MANIFEST VARIABLES REPRESENTING STUDENT HOME BACKGROUND IN CHILE

Variable Number	Short Name	Long Name
112	FOCC	Father's Occupation
116	FED	Father's Education in Years
117	MED	Mother's Education in Years
125	Q62G49	Parents Insist on Correct Speech
126	Q62G50	Parents Check Spelling
127	Q62G51	Use of Dictionary at Home
128	Q62G52	Parents Encourage Reading
129	Q62G53	Parents' Interest in School
132	Q62G54	Parents' Encourage Museums and Concerts
133	Q62G55	Number of Books in the Home
733	Q6R04	Magazines Received at Home per Month
751	Q6R22	Newspapers Family Receives Daily

The relationships between the manifest variables and the corresponding latent variable is referred to as an outer relation. There are primarily two ways of constructing latent variables, the first involving correlation or simple regression (Model A), the second involving multiple regression (Model B). At the present state of development of NIPALS methods, it is unclear under what circumstances it is most appropriate to use Model A and under what circumstances it is most appropriate to use Model B. For this reason, both models were tested in each country. The relationships among the latent variables are referred to as inner relations. These outer and inner relations are illustrated in Figure 1. For the purposes of the present report, only the inner relations are of interest. More complete details about the construction of NIPALS latent variables can be found in the Annex B.

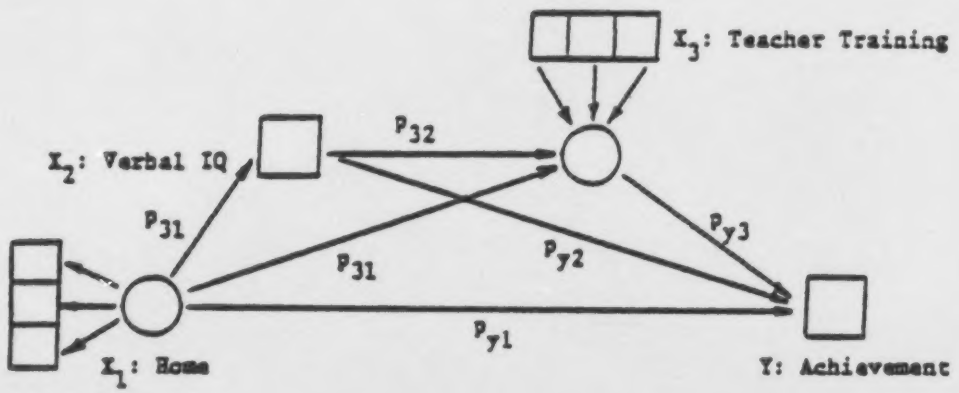


Figure 1: A Simple NIPALS Model with Inward and Outward Indicating Latent Variables

In the analysis for the present report, a relatively simple model was used, although there is every reason for supposing that the use of somewhat more elaborate models and the corresponding estimation procedures would yield improved estimates of the parameters. The limitations at this time are due to the absence of a general NIPALS program capable of efficiently handling large quantities of data, in terms of both numbers of variables and numbers of cases. Such a program is currently under development at the Institute of International Education in Stockholm. In the absence of such a general program, the estimation procedures have taken the form of a large number of separate regression runs on the computer--at least one for each outer relation and one for each inner relation. A general NIPALS program can make better use of the information available in the data by avoiding information loss due to the exigencies deriving from the large amount of handwork involved in a large series of separate computer runs.

A Strategy for Latent Variable Construction

The NIPALS procedure described above is only half of the story behind the construction of the latent variables used in the present study. A general principle underlying the entire analysis is that at each step, the procedure should be based on theoretical considerations and should reflect a sufficiently elaborate conceptual model of the schooling situation. As a result, when the latent variables were constructed, it was regarded as inappropriate to simply aggregate variables without consideration to the dimensionality of the underlying phenomena. Thus there were two major steps in the strategy for the construction of latent variables. In the first step, a factor analytic procedure was used to construct conceptually and empirically distinct and homogeneous compound variables (first-order latent variables) from among the questionnaire items concerning, for example, the home background. These compounds represent the basic unitary dimensions of the respective phenomena. These compounds are in turn combined using NIPALS procedures into measures (higher-order latent variables) representing the multidimensionality of the underlying phenomenon.

Table 5: FACTOR ANALYSIS OVER SOCIOECONOMIC STATUS VARIABLES IN CHILE

Variable	Factor Loading
Father's Occupation	.72
Father's Education	.84
Mother's Education	.80
Number of Books in the Home	.67

This process can be illustrated by reference to the manifest variables for Chile shown in Table 4. Although those variables all represent characteristics of the home, they are by no means conceptually homogeneous. At least three variables--Father's Occupation, Father's Education, and Mother's Education--concern socioeconomic status. A fourth variable--Number of Books in the Home--could conceivably also represent socioeconomic status, since number of books could be a function of family income. The remaining variables clearly represent other aspects of the home, but the underlying dimensionality is unclear. A factor analysis (principal components) over these four variables showed one factor ($\lambda>1$), but the factor loadings, shown in Table 5, suggest that Number of Books in the Home is something of an outlier empirically, as it is also conceptually. A second factor analysis (principal components with varimax rotation) concerning Number of Books in the Home together with other home background variables, is shown in Table 6.

Table 6: FACTOR ANALYSIS OVER OTHER HOME BACKGROUND VARIABLES IN CHILE

Variable	Factor 1	Factor 2
Parents Insist on Correct Speech	.58	-.15
Parents Check Spelling	.68	-.23
Use of Dictionary at Home	-.35	.47
Parents Encourage Reading	.73	.08
Parents' Interest in School	.61	-.16
Parents Encourage Museums & Concerts	.45	-.36
Number of Books in the Home	-.21	.72
Magazines Received at Home per Month	-.12	.71
Newspapers Family Receives Daily	.01	.71

Two factors emerge, and inspection reveals that the factors correspond conceptually to two different dimensions of the home, namely the behavioral and the material. On the basis of these empirical results and conceptual considerations, four variables emerged: (1) Father's Occupation; (2) Parents' Education; (3) Home Reinforcement and Practices, and (4) Home Material Environment. Home Reinforcement and Practices was computed as the mean of the five items representing parental behavior. Home Material Environment was computed as the mean of the four items concerning material resources in the home. Use of Dictionary was taken on the basis of the factor analysis to represent a material aspect of the home. It would seem that the item really indicated whether or not the family owned a dictionary, an interpretation which is not inconsistent with the wording of the item on the questionnaire. These four variables--Father's Occupation, Parents' Education, Home Reinforcement and Practice, and Home Material Environment--which represent various specific dimensions of the home, were then combined, in accordance with NIPALS principles, into the two higher-order latent variables, AHOME and BHOME, for Models A and B, respectively, which represent the global phenomenon of the Home.

Table 7: HIGHER ORDER LATENT VARIABLES IN THE HYPOTHESIZED CAUSAL AND ASSOCIATIONAL ORDER

	Chile	India	Extended Labels
Exogenous Variables	AREGION, BREGION	REGION	Geographic Region
	AHOME, BHOME	AHOME, BHOME	Student Home Background
	STUSEX	STUSEX	Sex of Student
	VERBALIQ	VERBALIQ	Verbal IQ
	AGE	AGE	Age of Student in Months
Endogenous Variables	GRADE	GRADE	Grade of Student
	HOMWRK	HOMWRK	Student Homework Conditions
	ASCHTYPE, BSCHTYPE	ASCHTYPE	Type of School
	ENROLL	ENROLL	School Enrollment
	ARESOURC, BRESOURC	ARESOURC, BRESOURC	School Resources
	TEASEX	TEASEX	Sex of Science Teacher
	SCITEEXP	SCITEEXP	Science Teacher Age and Experience
	ATEATRN, BTEATRN	ATEATRN, BTEATRN	Teacher Training
	AMETHODS, BMETHODS	AMETHODS, BMETHODS	Teaching Methods
	SCHATMOS	ASCATMOS, BSCATMOS	School Atmosphere
	OPSCI	OPSCI	Student's Opportunity to Learn Science
Criterion Variable	CSCI	CSCI	Student Corrected Science Score

Using the above strategy, the large number of items in the IEA data files were reduced to a total of 17 latent variables, covering the school science learning situation in as wide a scope as possible within the limits of the IEA data bank. The construction of the latent variables is described in more detail in Annex B, Section 2. The final latent variables used in the analysis are shown in Table 7.

The Teacher Training Latent Variable

Science teachers responded to a total of 14 questionnaire items concerning their educational backgrounds. For some of these the several responses were analyzed separately, so that the total number of manifest variables was somewhat larger. The manifest variables are shown in Table 8. The nationally coded items of course, varied from country to country, depending on the national system of teacher training. The definitions of the different categories in Chile and India are shown in Tables 9 and 10, respectively. The percent of teachers in each category is also reported in Tables 9 and 10.

Table 8: VARIABLES REPRESENTING TEACHER TRAINING

Number	Variable
346	University Degree in Science
347	University Degree in Mother Tongue
348	University Degree in Another Subject
349	No University Degree
352	Years of Education, Primary & Secondary
353	Years of Education, Post-Secondary
384-393	Type of Education - National Codes
395	Semesters Training, Physics
396	Semesters Training, Chemistry
397	Semesters Training, Biology
398	Semesters Training, Geology
399	Semesters Training, Other Science
400	In-Service Training, Physics
401	In-Service Training, Chemistry
402	In-Service Training, Biology
403	In-Service Training, Geology
404	In-Service Training, Other Science

Table 9: TYPE OF TEACHER TRAINING IN CHILE

Category	Definition	Percent
A	No training	1.7
B	Any type of training given by an institution not granting a professional or specialized degree	5.9
C	Some studies in special schools for training of elementary school teachers (non-university "escuela normal")	11.1
D	A degree obtained in the same type of school as in Category C	37.0
E	Some university studies	18.3
F	University degree, but not in subject presently taught	1.1
G	University degree for secondary school teaching in subject presently taught	25.0

Table 10: TYPE OF TEACHER TRAINING IN INDIA

Category	Definition	Percent
A	None after high/higher secondary school	9.6
B	Intermediate or technical school	11.4
C	Training school	10.1
D	Training school offering the "basic education" curriculum	37.6
E	General degree college (up to B.A.: only)	5.8
F	Teacher training college (up to B. Ed. only)	4.8
H	General degree college offering M.A., M.S., and Master of Commerce degrees also	13.8
I	Teacher training college offering M. Ed. degrees also	2.3
J	University	4.5

Some comparisons are useful in order to see the science teachers investigated here in international perspective. Table 11 shows selected characteristics concerning the education and professionalism of science teachers in Chile and India, compared with teachers in the industrialized countries in the IEA survey. None of the indicators available in the IEA data bank reveals anything about the quality of the training teachers have had. Judging from the available qualitative figures, however, it can be seen that, with respect to all indicators, the sampled Chilean teachers were superior to the mean for the industrialized countries. The sampled Indian teachers, however, tended to be very inferior to the teachers in the industrialized countries. This difference between Chilean and Indian teachers should be kept in mind when interpreting the results of the analysis.

Table 11: CHARACTERISTICS OF SCIENCE TEACHERS IN CHILE AND INDIA, COMPARED WITH THE INDUSTRIALIZED COUNTRIES

Variables	Chile	India	Industrialized Countries		
			Mean	Low	High
% University Trained Science Specialists	60	26	56	18	93
Mean Years of Post Secondary Schooling	4.2	2.3	3.7	2.8	4.8
% with 2 Years or Less Post Secondary Schooling	15	53	18	0	58
% with 5 Years or More Post Secondary Schooling	66	21	37	11	85
% Members in Subject Association	62	6	38	13	74
% Read Teaching Journal Regularly	48	17	42	18	66
% Read Science Journal Regularly	64	23	55	29	82

Source: Comber and Keeves, pp. 82-83.

Some of the items in Table 8 are uninteresting in the form in which they appear in the original data files. First, to use all categories of a categorical variable introduces redundancies information. It is often necessary to leave out one category, and it is usually desirable to leave out a reasonably large "base" category, to which all other categories can be meaningfully compared. Variables 346 to 349 are based on a single questionnaire item, each variable being computed as the per cent of science teachers in the school responding to a given alternative—University Degree in Science, University Degree in Mother Tongue, University Degree in Another Subject, No University Degree. In the subsequent analysis, the last category, containing some 50 per cent of the teachers in both countries, was deleted. Second, Variables 395 to 404 were not interesting as separate measures of semesters training and weeks of in-service training in the separate science subjects, since the criterion was the total science score, not specific subtests. Thus these two sets of measures were combined into two variables: (1) TESEMSCI, Total Semesters Science Training, and (2) TEINSSCI, Total Weeks In-Service Training. Factor analysis over the resulting variables led to the construction of first-order latent variables representing different types and levels of teacher training. In Chile, two latent variables were constructed:

(1) Science Teacher Has University Degree, a compound of:

University Degree in Science	(+)
Years of Post-Secondary Education	(+)
Total Semesters Science Training	(+)
Degree in Normal School	(-)
Degree at University	(+)

(2) Science Teacher Has Secondary and In-Service Training, a compound of:

Years of Primary and Secondary Education	(+)
Total Weeks of In-Service Training	(+)
No Training	(-)

In India, two different latent variables were constructed:

(1) Science Teacher Has Masters Degree, a compound of:

University Degree in Science	(+)
Years of Post-Secondary Education	(+)
Total Semesters Science Training	(+)
M.A. or M.S. Degree	(+)

(2) Science Teacher Has Non-Science Degree, a compound of:

University Degree in Mother Tongue	(+)
University Degree in Another Subject	(+)
No Post-Secondary Education	(-)
Teacher Training College	(+)

These latent variables, together with the remaining nationally defined Type of Education variables, were then combined to form NIPALS Model A and Model B higher-order latent variables (ATEATRN and BTEATRN in Tables 7, 12, 13, and A-1 to A-4).

The Path Model

The variables listed in Table 7 constituted the basis for the analysis presented here. The variables are shown in a causal order. We will refer below to causal relationships and non-causal, man-made associations. The expressions "causal relationships" and "non-causal", "man-made associations" here refer to attributes of a hypothetical model, in particular to the relationship between two or more elements in the model, not to any empirical regularities in the data.

Causal path analysis is based on the assumption that a causal order can be established among the endogenous variables, including the criterion variable. Variables taken to be exogenous need not be causally ordered, and the relationships among them need not be specified as causal or non-causal. Between the exogenous and the endogenous variables there is clearly an ordering. In Table 7, an attempt has been made to establish a general order among all variables, whereby variables may causally influence all variables below them, but they do not causally influence any variables above them. Thus, Region was hypothesized to have a causal effect on Home, Verbal IQ, and the criterion variable, Science Score, to give only a few examples. There may also be a non-causal association with other variables appearing below. Home was hypothesized to have a causal effect on Science Score and a non-causal association with Resources. With 17 variables in the model, there are too many interrelationships to discuss each one within the limited space available. Five variables were considered exogenous, i.e., possible relationships among these variables were ignored. As a result, 126 relationships (parameters) were estimated.

In summary, according to the model tested, each endogenous variable, including the criterion variable, Science Score, was specified as a linear function of all variables appearing above it in the list given in Table 7, plus a residual. Some relations were hypothesized as causal, others as non-causal. Each path analysis thus consisted of 12 regressions, using each variable from Grade to Science Score in turn as the dependent variable and all variables above the respective dependent variables as independent variables or predictors. In both countries, NIPALS Models A and B were tested.

The Parameter Estimates

In the present analysis, an attempt has been made to analyze the causal and non-causal relationships among a wide range of variables hypothesized to play a role in the schooling situation. The state of social and

educational research today is such that measures of broad phenomena generally lack a meaningful scale, even though specific indicators may have such a scale. The number of Books in the Home, Mother's Education in Years, etc., have clear scales, but the quality of the home as a whole, cannot be measured today in such a way as to yield an interpretable, independent scale. Under such circumstances the rationale for the use of concrete or unstandardized regression coefficients--namely, comparability of effects across samples--does not apply. The procedure here was therefore to use standardized regression coefficients as estimates of path effects. Standardized regression coefficients are equal to the unstandardized coefficients times the ratio of the standard deviation of the independent variable to the standard deviation of the dependent variable. The interpretation of a standardized path coefficient, p_{yx}, is as follows: A change of one standard deviation in X is associated with a change of p_{xy} times one standard deviation in Y, holding constant other variables influencing Y. Standardized path coefficients are sample bound. The same natural laws governing a given process might prevail in two different countries, but if the independent variables have different variances in the two countries, the corresponding standardized regression coefficients would be different in the two countries, whereas the unstandardized regression coefficients would be the same. For this reason, the concrete or unstandardized coefficient is regarded as a representation of the true natural laws governing a process (Tukey, 1954; Turner and Stevens, 1959). However, as Wright points out, the use of standardized coefficients has the advantage of enabling a direct and immediate comparison of the relative direct contibutions of the several independent variables to variation in the dependent variable (Wright, 1971). In the present analysis, standardized coefficients are used. It is appropriate to compare coefficients within the same sample, therefore, but in trying to interpret differences between countries, it must be remembered that observed differences may be due solely to differences in the variances of the independent variables. Under the assumption that the same underlying natural laws apply in two samples, the standardized regression coefficient will be greater in the sample in which the variance of the independent variable is greater.

The path coefficients (standardized regression coefficients) measure the <u>direct</u> effect of a given independent variable on the dependent variables, <u>ceteris paribus</u>. In the real world, however, other things are rarely constant. Instead, the school situation is characterized by a large network of interrelationships. This fact, in turn, gives rise to significant <u>indirect</u> effects. Thus for policy purposes, it is important to know not only the direct effects, but also the indirect effects. In the literature there has been some disagreement as to what measure of indirect effect is interesting, but it is generally agreed today that the interesting indirect effects are those operating through causally subsequent variables (Duncan, 1971; 1975). That is, when variables are ordered from causally prior to causally subsequent, the indirect effects are taken to be those which proceed from a given variable and flow through the subsequent variables in the established order. The total correlation between a given explanatory variable and the criterion variable can

thus be disaggregated into a direct component, an indirect component, and a component due to common causation, i.e., through causally prior variables. The direct effect plus the indirect effect, as described above, is referred to below as the total path effect or simply total effect.

THE PATH ANALYSIS

The path analyses were carried out using a backward elimination procedure with an F criterion of 3.84 ($p<.05$ at df=1, ∞) (Kim and Kohout, 1975). The results are shown in Tables A-1 to A-4 in Annex A. These tables show the standardized path (regression) coefficients for all endogenous variables, plus coefficients for the indirect paths and the total path effects for the criterion variable, Science Score. Also shown are the residual coefficients ($\sqrt{1-R^2}$) and the total (zero-order) correlations between the independent variables and the criterion. Standard errors for Chile were typically approximately 0.021 and for India, approximately 0.015. Thus the lowest path coefficient that can appear in Tables A-1 and A-2 is approximately 0.04, and in Tables A-3 and A-4, 0.03. Variables whose coefficients did not exceed these values were removed from the regression, and the table entries for these variables were omitted and treated as zero.

Examining Tables A-1 and A-2, some preliminary observations are in order. First, inasmuch as the samples in both countries cover several grades, it is necessary to enter Grade as a control variable in the analysis. What may be surprising is that Grade is seen to have a negative direct effect, and this requires explanation. The simple correlation between Grade and Science Score is positive, which is to say that students in higher grades tended to have higher science achievement than students in lower grades. Grade, however, even at this age level, is highly correlated with Verbal IQ ($r=.43$). This would not be the case in countries where all children in the relevant age group remained in school and grade promotion was based on age. In Chile, however, as noted above, more than 40 per cent of the age group were not in school, and almost 20 per cent of those in school were below the fifth grade. As soon as Verbal IQ is used as a control, the relationship between Grade and Science Score becomes negative. That is, students in the higher grades perform less well than their equally able school mates in the lower grades. As shown in Table 2, however, the Chilean sample covers many grades. In the higher grades, a great deal of specialization has occurred. The number of students in the Technical and Academic Scientific programs, however, is small, amounting to less than 5 per cent of the total sample and not more than 12 per cent at any grade level. A plausible interpretation is that for the students in the lower grades, the tested material was fresher, since it was being currently taught as a part of a primary school curriculum. The large majority of students in the higher grades, however, had not studied science for a year or two. They had forgotten many details, and their test

scores were therefore lower than those of their equally able younger school mates. 1/

Turning to Tables A-3 and A-4, it will be noted that in India, Grade does not have a negative direct effect on Science Score, as it does in Chile. This is probably a reflection of a lower degree of specialization in the Indian schools, so that larger proportions of school students continue to study science in some form in the higher grades. This problem, however, has not been investigated further.

A final observation is that in both Chile and India, the residual is smaller than Comber and Keeves reported (1973, p. 261). For their analysis, the unexplained residual was .87 for both countries.

Tables A-1 to A-4 provide the full results of the path analysis. They thus enable an overview of the full network of interrelationships at play in the school science learning situation. Table 12 provides a summary of the direct effects found in Tables A-1 to A-4. What is immediately obvious from Table 12 is that there is very nearly complete agreement between parameter estimates for NIPALS Models A and B. The differences can, as noted above, be taken as a measure of our ignorance as to the appropriate models and methods. There is also fair agreement between the results for Chile and India.

Comparing the four columns in Table 12, it can be noted that there are several variables for which the direct effect parameters for the four analyses tend consistently to be large compared to the differences between them. Thus Home tends to have a modest positive effect, while Verbal IQ tends to have a very strong effect. Teacher Training tends to have a modest or moderate effect. Methods tend to have a moderate effect, stronger than Home and second only to Verbal IQ. Region has only a slight effect. School Atmosphere has no effect. Other variables have inconsistent effects.

1/ It was discovered during the writing of the report that the Resource variable was incorrectly constructed in Chile. The correct values of the correlations between the Resource variables and Science Score should be low but positive. Due to its relatively low value both in its existing form and in its correct form, it is unlikely that the error has significantly influenced the results for the other variables.

Table 12: THE DEPENDENCE OF SCIENCE ACHIEVEMENT ON ITS EXPLANATORY VARIABLES. STANDARDIZED PATH COEFFICIENTS

Explanatory Variable	Chile		India		Range	
	Model A	Model B	Model A	Model B	Low	High
REGION*		.04			0	.04
HOME	.08	.07	.09	.08	.07	.09
STUSEX	-.16	-.14			-.16	0
VERBALIQ	.47	.46	.48	.46	.46	.48
AGE	.06	.06			0	.06
GRADE	-.12	-.13	.08	.09	-.13	.09
HOMWRK			.08	.08	0	.08
SCHTYPE			.07	.08	0	.08
ENROLI		-.08	.12	.12	-.08	.12
RESOURC	-.09	-.05	.06	.07	-.09	.07
TEASEX			-.09	-.09	-.09	0
SCITEEXP			.06	.06	0	.06
TEATRN	.07	.14	.07	.06	.06	.14
METHODS	.11	.18	.10	.10	.10	.18
SCHATMOS					0	0
OPSCI	.16	.15			0	.16
Residual	.80	.79	.77	.77		

Note. * A listing of variables is shown in Table 7.

Table 13 provides an overview of the total path effects. In general, the results are much the same, but now some effects become more clear. Whereas in India, Student Sex had no direct effect, its indirect effect was negative, i.e., girls tended to have lower scores than boys. It can be seen from Tables A-3 and A-4 that the major single reason for the negative indirect effect of Student Sex is that Student Sex is a major determinant of Teacher Sex (i.e., boys tend to have men teachers and girls tend to have women teachers), and Teacher Sex has a negative total effect.

Table 13: TOTAL PATH EFFECTS OF THE EXPLANATORY VARIABLES ON SCIENCE ACHIEVEMENT. TOTAL PATH COEFFICIENTS

Explanatory Variables	Chile		India		Range	
	Model A	Model B	Model A	Model B	Low	High
REGION	-.03	.02	.04	.04	-.03	.04
HOME	.05	.06	.10	.08	.05	.10
STUSEX	-.16	-.16	-.08	-.08	-.16	-.08
VERBALIQ	.50	.50	.56	.56	.50	.56
AGE	.06	.04	.03	.02	.02	.06
GRADE	-.07	-.08	.13	.14	-.08	.14
HOMWRK	.03	.02	.10	.10	.02	.10
SCHTYPE	.01	.01	.04	.07	.01	.07
ENROL1	-.01	-.06	.12	.12	-.06	.12
RESOURC	-.08	-.06	.09	.09	-.08	.09
TEASEX	-.05	-.06	-.10	-.10	-.10	-.05
SCITEEXP	.01	-.02	.08	.08	-.02	.08
TEATRN	.12	.11	.07	.07	.07	.12
METHODS	.11	.19	.10	.10	.10	.19
SCHATMOS					0	0
OPSCI	.16	.15			0	.16

Note: A listing of variables is shown in Table 7.

That is, all other things being equal, girls have as high science achievement scores as boys, but in reality all other things are not equal. Girls tend to have women teachers, and women teachers tend to be less "effective" (in the very restricted sense that the effect of Teacher Sex on Science Score is negative). A similar result is seen for Teacher Sex in Chile. Their Teacher Sex had no direct effect but a negative indirect effect. From Tables A-1 to A-2, it can be seen that the reason for the negative indirect effect is the negative effect of Teacher Sex on Teacher Training and Methods. That is, all other things being equal, women teachers tend to be as effective as men teachers. In reality, however, other things are not equal, and women teachers tend to have lower levels of training and to use less effective methods. This also illustrates the fact that causal and non-causal relationships are inextricably intertwined. Variations in methods can be hypothesized to "cause" variations in achievement, but differences in teacher training are "non-causally associated" with teacher sex. Women teachers, however, can be given the same training as men and can be taught to use the same methods as men. Teacher sex would then have no effect on teacher training or methods and thus would have no effect on student achievement.

DISCUSSION: THE EFFECTS OF TEACHERS ON SCIENCE ACHIEVEMENT

What does the present analysis suggest about the relative potential contributions to improvement of student cognitive outcomes? What role can be played by the teachers? In order to come to grips with these questions, it is necessary to have some scale with which to describe teacher training and changes in teacher training. Since no "natural" or "concrete" scale is available, we must use a scale based on the specific samples investigated. That is, we shall use a scale in which the scaling unit is the standard deviation of the teacher training variable in the respective samples. It will be an abstract scale which can be understood in concrete terms only by reference to the concrete circumstances in the country in question. We shall, of course, confine our thinking to the framework of the Population II teachers investigated here.

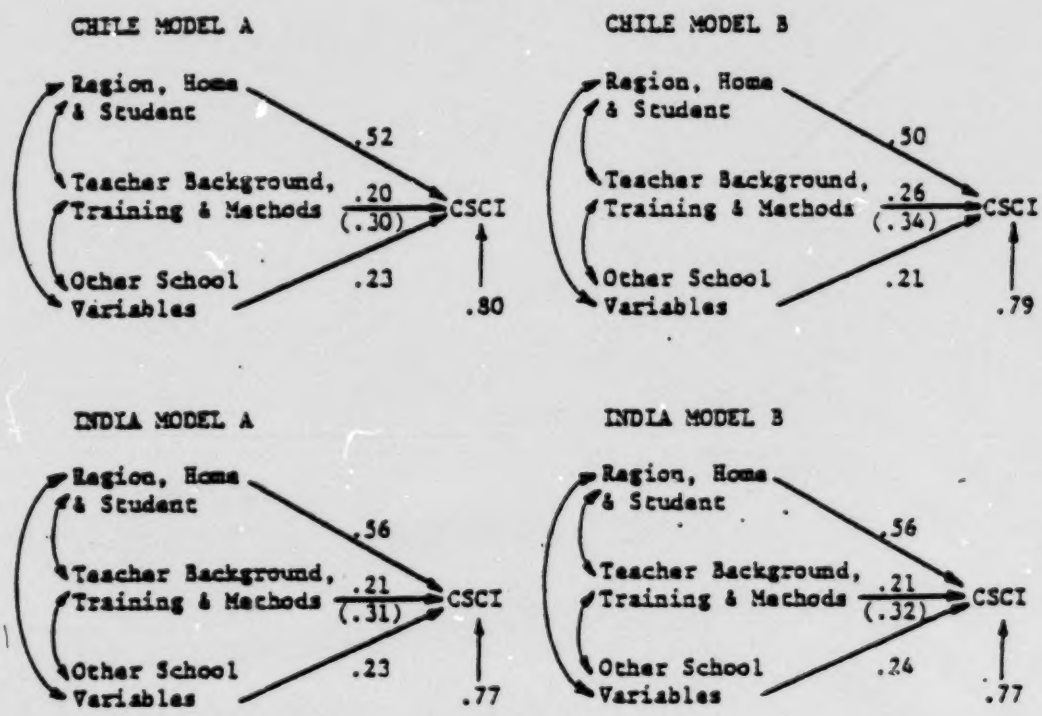
To begin with, let us, in our imagination, line up all teachers in a country in order, from the most poorly trained to the most highly trained. In making such rankings, we shall take into account all relevant forms of training, including in-service training. Let us assign a value of zero to the midpoint of that line of teachers. Let us, furthermore, assume that the teachers are normally distributed with respect to their training. That is, most teachers cluster around the mean in terms of training, with relatively few teachers at the extremes. In fact, we can define scale units (standard deviations) such that approximately 68 per cent of the teachers fall between scale points -1 and +1, an additional 27 percent fall outside these points but between scale points -2 and +2, and the remaining 5 percent fall outside these points. Now since most teachers have nearly the same training, the mean level of training of

the upper 50 per cent of teachers is not extremely different from the mean level of training of the whole population of teachers. In fact, the whole population of teachers has, as noted above, a mean level of training set at zero on our abstract scale, and the most highly trained 50 per cent of teachers have a level of training of approximately 0.7, i.e., the same level of training as teachers at the scale point 0.7 (further discussion of the methods of calculation in this example are given in Section 3 of Annex B). It can be shown that if the level of formal training (such as it was, as measured by the Teacher Training variable) of all teachers were raised in the future to the mean of the most highly trained 50 per cent of all teachers today, then, according to the total path effects from the above analysis, mean Science Score would rise from 9.6 to 10.3 in Chile and from 8.3 to 8.7 in India. These increases represent 8 and 55 per cent of a standard deviation in achievement in the respective countries. These figures include indirect effects through causally subsequent variables.

Suppose, however, that we regard the parameter estimate for the Teacher Training variable as too conservative an estimate, since it is based on teacher training as it was among the sampled teachers. Suppose, instead, that we regard all teacher variables, including teacher background, teaching methods, and the residual school variable, Opportunity to Learn, as potential sources of change through various forms of teacher training. That is, suppose we are able, through various forms of training, to get less experienced, poorly trained, less successful teachers to exhibit the same kinds of classroom behavior as experienced, well trained, successful teachers today, and at the same time improve the classroom behavior even of today's experienced and trained teachers. What would the effects of such changes be? In posing such a problem, teacher training variables are really taken to be surrogates for measures of teacher classroom behavior, which, due to the crudeness of our instruments today, we are not able to measure directly. For the objective of improving student achievement, teacher training is of no intrinsic interest--only teacher classroom behavior. It is from the objective of improving teacher classroom behavior that teacher training becomes intrinsically interesting. From that point of view, however, formal teacher training, such as it was, is only one of many alternatives. Similarly, other teacher variables, such as sex, experience, etc., are also interesting only as surrogates for behavioral measures. No behavior is, in any final sense, bound to sex, experience, training, etc. What we observe are established patterns of behavior, but these patterns can be changed through will. Women teachers can learn those behaviors which their male colleagues exhibit which account for the effects shown in Tables 12 and 13. In that sense, all teacher variables are subject to manipulation because teachers themselves are human and have a will to learn new behaviors, i.e., to manipulate their own classroom behavior.

On the basis of the coefficients shown in Tables A-1 to A-4, approximations to the direct effects of student, teacher, and school aggregates were computed (see Annex B, Section 4). The results are shown in Figure 2.

If we are to replicate our above example using the coefficients shown in Figure 2, we will line up all teachers in a country not on the basis of their formal training but on the basis of the effectiveness of their behaviors. We will assume a normal distribution with a mean of zero and standard deviation of 1. Now if the mean effectiveness of all teachers could be upgraded, by any form of teacher training, to the mean effectiveness of the most effective 50 per cent of all teachers today, then, according to the coefficients shown in Figure 2, mean Science Score would rise from 9.6 to 11.0 in Chile (mean of estimates for Models A and B) and from 8.3 to 9.6 in India. These increases correspond to 16 and 15 per cent of a standard deviation in achievement in the respective countries.



NOTE: The numbers in parentheses indicate aggregated effects of teacher and school variables together.

Figure 2. Simplified Path Models Showing Aggregated Effects of Student, Teacher, and School Variables.

Are these estimates (which are certainly statistically significant) socially significant? Do they make investment in teacher training programs worthwhile? What changes can be expected if teacher training programs are not carried out? From Table 12 it can be seen that the residual influence on Science Score is approximately 0.80 and thus by far the strongest aggregate effect. The residual effect is stronger than the combined effects of all student, teacher, and school variables measured. Thus, improvement in this residual of factors could lead to far larger improvements in achievement levels than those mentioned above. These residual factors, however, are, by definition, unknown to us. Until they become known to us, they also lie outside our control. They may rise and lead to improved cognitive performance, or they may fall and lead to even lower levels of achievement than today. Or the combination of factors may not change at all in the aggregate, leading to unchanged performance. The student background variables, on the other hand, are known to us but outside the range of control of educational authorities. The teacher and school variables, however, are known to us and are within the range of control of the educational authorities. Improvement in both sets of factors involves financial costs. Neither textbooks and AV materials nor teacher training programs are free.

It would be quite beyond the scope of the present report to attempt to indicate whether or under what circumstances it would be most appropriate to improve teacher training or to improve other school factors. That would certainly depend on the relative availability of these two factors, on the relative costs of labor and materials, on the relative suitability of expatriate teachers and foreign textbooks and other instructional materials, etc. For example, a country may experience a relative redundancy of qualified teachers and a scarcity of buildings and materials, or the contrary conditions may prevail. There may be an adequate supply of teachers from the former colonial country, but from a pedagogical point of view and from the point of view of national aspirations, such teachers may be deemed inappropriate in the future. Alternatively, there may be an adequate supply of teachers from a neighboring country with similar language and culture, and such teachers may be deemed quite appropriate for the present. Obviously, decisions concerning specific investments in specific countries require studies of a very different kind from the one reported here.

It would likewise be beyond the scope of the present report to attempt to indicate whether, in a particular country, it is wise to invest at all in upgrading student achievement. This would depend on such factors as the redundancy or scarcity of trained labor, the intrinsic value of education, etc. Moreover, the labor force is clearly segmented both horizontally and vertically, so that the question of redundancy or scarcity of trained labor does not apply to a homogeneous population as a whole but to more or less distinct groups in the population and types and levels of education. Such decisions also require other kinds of studies.

An important conclusion can be drawn, however. The estimates of teacher effects on student science achievement calculated in the present study do not provide evidence on what economic rate of return countries

might gain on investments in teacher training programs. That depends on a variety of pedagogical and economic considerations. What they do suggest however, is that if investments are made in teacher training programs, there will be a return on the investment in terms of increases in the level of student cognitive outcomes of schooling.

ANNEX A

RESULTS OF THE PATH ANALYSIS

Table A-1: PATH COEFFICIENT MATRIX FOR CHILE. MODEL A

Independent Variables / Dependent Variables	GRADE	HOMWRK	ASCHTYPE	ENROLI	ARESOURC	TEASEX	SCITEXP	ATEATRN	AMETHODS	SCHATMOS	OPSCI	CSCI	INDIRECT PATHS	TOTAL PATHS	TOTAL CORRELATION
AREGION*		-.06		.13		.08	.20	-.13			-.05		-.03	-.03	.08
AHOME	.38			.08	.08		.12	.09	-.14	-.40	.06	.08	-.03	.05	.19
STUSEX				.07		.42	.12	.12	.06			-.16	.0	-.16	-.19
VERBALIQ	.33		.15	-.10				.16	.14	.25	.11	.47	.03	.50	.52
AGE	.24		.06		.09	-.06		.10		.07		.06	-.01	.06	.05
GRADE				.39	.10	-.16		.10	-.22	.14	.41	-.12	.05	-.07	.20
HOMWRK					-.14	.05	.06	.06	.04	-.08	.06		.03	.03	.04
ASCHTYPE					-.07	-.07	-.09			.10			.01	.01	.11
ENROLI					-.12	.06	.10	-.06			-.08		-.01	-.01	-.01
ARESOURC						-.06	.04	.11		-.12	-.06	-.09	.01	-.08	-.06
TEASEX							.10	-.32	-.08				-.05	-.05	-.18
SCITEEXP								-.10	.20	.06			.01	.01	0
ATEATRN									.48			.07	.05	.12	.23
AMETHODS												.11	0	.11	.19
SCHATMOS													0	0	.03
OPSCI												.16	0	.16	.28
Residual	.77	1.00	.99	.90	.97	.88	.94	.87	.84	.88	.88	.80			

Note: * A listing of variables is shown in Table 7.

Table A-2: PATH COEFFICIENT MATRIX FOR CHILE. MODEL B

Independent Variables / Dependent Variables	GRADE	HOMWRK	BSCHTYPE	ENROLI	BRESOURC	TEASEX	SCIEEXP	BTEATRN	BMETHODS	SCHATMOS	OPSCI	CSCI	INDIRECT PATHS	TOTAL PATHS	TOTAL CORRELATION
BREGION*		-.07	-.06	.10		.08	.18	-.08				.04	-.02	.02	.09
BHOME	.25	.06			.08		.09	.09		-.41		.07	-.02	.06	.15
STUSEX				.08		.41	.12		.07			-.14	-.02	-.16	-.19
VERBALIQ	.39		.17	-.09				.09	.22	.23	.10	.46	.04	.50	.52
AGE	.26		.06		.08	-.07		.05		.07		.06	-.02	.04	.05
GRADE		-.06		.44	.09	-.17		.27	-.08	.08	.41	-.13	.05	-.08	.20
HOMWRK					-.14	.06	.06		.08	-.05	.04		.02	.02	.04
BSCHTYPE				-.04	-.09	-.06	-.09			.14	-.05		.01	.01	.11
ENROLI					-.13	.07	.13	.14	.10		-.12	-.08	.02	-.06	-.01
BRESOURC							.05		.06	-.13	-.10	-.05	0	-.06	-.04
TEASEX							.09	-.15	-.24		.06		-.06	-.06	-.18
SCITEEXP								-.16		.06			-.02	-.02	0
BTEATRN									-.28		.16	.14	-.03	.11	.22
BMETHODS											.06	.18	.01	.19	.23
SCHATMOS													0	0	.08
OPSCI												.15	0	.15	.28
Residual	.82	1.00	.98	.90	.97	.88	.94	.86	.93	.87	.87	.79			

Note: * A listing of variables is shown in Table 7.

Table A-3: PATH COEFFICIENT MATRIX FOR INDIA. MODEL A

Independent Variables / Dependent Variables	GRADE	HOMWRK	BSCHTYPE	ENROLI	BRESOURC	TEASEX	SCIEEXP	BTEATRN	BMETHODS	SCHATMOS	OPSCI	CSCI	INDIRECT PATHS	TOTAL PATHS	TOTAL CORRELATION
REGION*	.08		-.23	-.26		.10	.16				.20		.04	.04	.10
AHOME	.14					.06		-.04		.06	-.04	.09	.01	.10	.12
STUSEX	-.05	-.10	.07		-.08	.58	-.08						-.08	-.08	-.04
VERBALIQ	.24		.07	.07	.04	-.09	.17	.10	.10	.21	-.12	.48	.08	.56	.57
AGE	.29		-.04	-.07		.04	-.05	-.06		.05			.03	.03	.03
GRADE			.43	.18	.17	-.08	-.08				.20	.08	.05	.13	.28
HOMWRK			.14		.07	.10	.22			.06	.08	.08	.02	.10	.11
ASCHTYPE				-.17	.12	.09	-.24			-.05		.07	-.04	.04	.19
ENROLI					.18	.14	-.11	.04				.12	0	.12	.20
ARESOURC						-.05	-.05	.13	.15		.25	.06	.02	.09	.22
TEASEX							-.09					-.09	-.01	-.10	-.08
SCITEEXP								.28				.06	.02	.08	.10
ATEATRN									.06	.05	.14	.07	.01	.07	.18
AMETHODS											.07	.10	0	.10	.19
ASCHATMOS													0	0	.13
OPSCI													0	0	.11
Residual	.91	1.00	.87	.94	.94	.75	.90	.94	.98	.97	.89	.77			

*Note: A listing of variables is shown in Table 7.

Table A-4: PATH COEFFICIENT MATRIX FOR INDIA. MODEL B

Independent Variables / Dependent Variables	GRADE	HOMWRK	ASCHTYPE	ENROLI	ARESOURC	TEASEX	SCITEEXP	ATEATRN	AMETHODS	ASCATMOS	OPSCI	CSCI	INDIRECT PATHS	TOTAL PATHS	TOTAL CORRELATION
REGION *	.10		-.17	.29		.11	.18				.19		.04	.04	.10
BHOME	.09			-.05		.04	-.04		-.04	.04		.08	0	.08	.12
STUSEX	-.04	-.10	.11		-.08	.58	-.08						-.08	-.08	-.04
VERBALIQ	.23		.11	.06	.05	-.10	.18	.09	.15	.19	-.13	.46	.10	.56	.57
AGE	.29			-.06		.03	-.05	-.06		.04			.02	.02	.03
GRADE			.32	.13	.14	-.09	-.12				.21	.09	.05	.14	.28
HOMWRK			.13		.07	.09	.21			.06	.08	.08	.02	.10	.11
BSCHTYPE				.06	.11	.15	-.18	.06	-.06	-.05		.08	-.01	.07	.21
ENROLI					.17	.13	-.09					.12	0	.12	.20
BRESOURC						-.03	-.08	.16	.12		.22	.07	.02	.09	.22
TEASEX							-.08					-.09	-.01	-.10	-.08
SCITEEXP								.28				.06	.02	.08	.10
BTEATRN									.05		.15	.06	0	.07	.18
BMETHODS											.06	.10	0	.10	.19
BSCHATMOS													0	0	.10
OPSCI													0	0	.11
Residual	.92	1.00	.91	.94	.95	.74	.91	.94	.98	.98	.90	.77			

* Note: A listing of variables is shown in Table 7.

BIBLIOGRAPHY

COLEMAN, James S. "Methods and Results in the IEA Studies of Effects of School on Learning." Review of Educational Research. 45:335-386, 1975.

COMBER, L.C., and John P. Keeves. Science Education in Nineteen Countries. Stockholm: Almqvist and Wiksell, 1973.

DUNCAN, Otis D. "Path Analysis: Sociological Examples," in H. M. Blalock, Jr. Causal Models in the Social Sciences. New York: Macmillan, 1971, pp. 101-114.

DUNCAN, Otis D. Introduction to Structural Equation Models. New York: Academic Press, 1975.

JORESKOG, K. G. "A General Method for Estimating a Linear Structural Equation System," in Structural Equation Models in the Social Sciences. New York: Seminar Press, 1973, pp. 85-112.

JORESKOG, K. G. "Structural Equation Models in the Social Sciences: Specification, Estimation and Testing," Research Report 76-9. Uppsala Sweden Institute of Statistics. 1976.

KIM, Jae-on and Frank J. Kobout. "Multiple Regression Analysis: Subprogram Regression," in Norman H. Nie, et. al., (eds.) SPSS: Statistical Package for the Social Sciences (Second edition). New York: McGraw-Hill, 1975.

LAZARSFELD, Paul. "Latent Structure Analysis," in I.S. Koch (ed.), Psychology: A Study of Science III. New York: McGraw-Hill, 1959.

NOONAN, Richard D. School Resources, Social Class, and Student Achievement. Stockholm: Almqvist and Wiksell, 1976.

NOONAN, Richard D. "The Effects of Teacher Upgrading and Domestication in Botswana: A Path-Analytic Study of Causal and Allocation Effects of Teacher Training." Annex in Final Report of the National Commission on Education in Botswana, 1977.

NOONAN, Richard and Herman Wold. "NIPALS Path Modelling With Latent Variables: Analyzing School Survey Data Using Nonlinear Iterative Partial Least Squares," Scandinavian Journal of Educational Research. 21:33-61, 1977.

PEAKER, Gilbert F. An Empirical Study of Education in Twenty-One Countries: A Technical Report. Stockholm: Almqvist and Wiksell, 1975.

TUKEY, John W. "Causation, Regression and Path Analysis," in O. Kempthorne, et. al., (eds.). Statistics and Mathematics in Biology. Ames, Iowa: Iowa State College Press, 1954, pp. 35-66.

TURNER, M. E. and Stevens, C.D. "The Regression Analysis of Causal Paths," Biometrics. 15:236-258, 1959.

WOLD, Herman, "Nonlinear Iterative Partial Least Squares (NIPALS) Modelling: Some Current Developments," in P. R. Krishnaiah (ed.), Multivariate Analysis - III. New York: Academic Press, 1973. pp. 383-407.

WOLD, Herman. "Soft Modelling by Latent Variables: the Nonlinear Iterative Partial Least Squares (NIPALS) Approach," in J. Gani (ed.), Perspectives in Probability and Statistics. New York: Applied Probability Trust, 1976, pp. 117-142.

WRIGHT, Sewell. "The Method of Path Coefficients," Annals of Mathematical Statistics. 5:161-215, 1934.

ANNEX TABLE I

TYPOLOGY OF STUDIES RELATING TEACHER CHARACTERISTICS

AND STUDENT ACHIEVEMENT IN LESS DEVELOPED COUNTRIES

	SURVEY STUDIES		EXPERIMENTAL STUDIES	
	Primary Level	Secondary Level	Primary Level	Secondary Level
MULTI-VARIATE STUDIES	Carnoy (1971) Carroll (1975) Comber & Keeves (1973) Farrell & Schiefelbein (1975) Fuller & Chantavanich (1976) Heyneman (1976 a & b) Lewis & Massad (1975) Levy (1971) Purves (1973) Ryan (1972) Shukla (1974) Thias & Carnoy (1972) Thorndike (1973)	Beebout (1972) Bibby & Pell (1974) Carnoy (1971) Carroll (1975) Comber & Keeves (1973) Currie (1977) Klees (1974) Lewis & Massad (1975) Purves (1973) Shukla (1974) Silvey (1972) Somerset (1968) Thias & Carnoy (1972) Thorndike (1973) Youdi (1972)	Nasoetion, et al (1976)	Hornik (1975) Okunrotifa (1974; 1975)
BI-VARIATE STUDIES	Heyneman (1976b) Husén (1977) Izquierdo & Guzman (1971) Philippines Dept. of Education & Culture (1976) Schmelkes (1972) Williams (1965)	Durojaiye (1974) Husen (1977) Windham (1970)	Ellson (1973) Rowe (1966)	

ANNEX TABLE II

COUNTRIES REPRESENTED IN STUDIES COVERED BY REPORT

Primary Level	Secondary Level
Botswana	Botswana
Chile	Chile
Guatemala	Congo
Hong Kong	El Salvador
India	Ghana
Indonesia	India
Iran	Iran
Kenya	Malaysia
Malaysia	Mexico
Mexico	Nigeria
Philippines	Puerto Rico
Puerto Rico	Sierra Leone
Thailand	Thailand
Uganda	Uganda
Total Countries Represented = 19	

ANNEX TABLE III

TEACHER VARIABLES BY RESEARCH AUTHOR(S)

Author(s)	Background				Qualification						Behavior & Attitudes					IEA
	Sex	Age	SES	Home English	Educ Attmt	Educ Qual	Cog Abil	Tea Exp	Sal	Upgr Pr	Att to Studs	Meth	Abs Pun	Job	Behav	Block
Beebout						x		x								
Bibby & Peil						x			x							
Carnoy	x				x	x		x								
Carroll	x					x		x								x
Comber & Keeves	x					x									x	x
Currie						x										
Durojaiye											x			x		
Ellson						x						x				
Farrell & Schiefelbein		x	x													
Fuller & Chantavanich		x			x	x	x				x		x			
Heyneman			x	x	x	x	x	x								
Hornik												x				
Husén		x			x	x		x		x						
Izquierdo & Guzman					x		x	x					x	x		
Klees	x	x				x		x				x		x		
Lewis & Massad	x						x								x	x
Levy					x				x							
Nasoetion, et al.										x						
Okunrotifa												x				
Philippine Ed & Culture											x					
Purves	x				x											x
Rowe											x					
Ryan	x		x				x							x		
Shukla																x
Schmelkes							x	x								
Silvey						x										
Somerset						x								x		
Thias & Carnoy								x	x							
Thorndike																x
Williams						x										
Windham						x										
Youdi						x										

Note: The order of the above 16 variables corresponds to that used in the text.

ANNEX TABLE IV

TEACHER VARIABLES AND RELATIONSHIPS TO STUDENT PERFORMANCE (p. 1)

Independent Variable	Author(s)	Country	School Level[a]	Criterion Variable	Relationship +	0	−	Comments
	A. DEMOGRAPHIC AND BACKGROUND VARIABLES							
1. Teacher Sex (M=1, F=2)								
	Carnoy	Puerto Rico	P	Spanish Reading & Gen. Ability			−	% male teachers + related to high Ach for P grades but − for S grades.
			S	Same	+			
	Klees	Mexico	S	Math & Spanish		0	−	Males more effective for Math; no differences for Language. No figures.
	Ryan	Iran	P	Math & Language	+			r = .28
		IEA Between-School Comparisons						
	Comber & Keeves	Chile	Pop II	Science Ach			−	r = −.32, p < .01
		Chile	Pop IV	Science Ach			−	r = −.46, p < .01
		India	Pop I	Science Ach		0		r = −.04, NS
		India	Pop IV	Science Ach		0		r = −.05, NS
		Iran	Pop IV	Science Ach		0		r = −.12, NS

[a] P = primary grades, S = secondary grades.

Independent Variable	Author(s)	Country	School Level[a]	Criterion Variable	Relationship +	0	-	Comments
1. Teacher Sex (continued)								
			IEA Between-Student Comparisons					
	Carroll	Chile	Pop IV	French Reading	+			t = 3.36, p < .005
		Chile	Pop IV	French Listening	+			t = 6.51, p < .005
	Comber & Keeves	Chile	Pop I	Science Ach			-	r = -.10, p < .01
		Chile	Pop II	Science Ach			-	r = -.23, p < .01
		India	Pop I	Science Ach	+			r = .11, p < .01
		India	Pop II	Science Ach			-	r = -.09, p < .01
		Iran	Pop I	Science Ach			-	r = -.05, p < .05
		Iran	Pop II	Science Ach	+			r = .08, p < .01
		Thailand	Pop II	Science Ach			-	r = -.07, p < .01
	Lewis & Massad	Chile	Pop IV	English Reading			-	r = -.23, p < .01
		Chile	Pop IV	English Listening	+			r = .09, p < .01
		Thailand	Pop II	English Reading	+			r = .06, p < .01
		Thailand	Pop IV	English Reading		0		r = .02, NS
	Purves	Chile	Pop II	Literature			-	r = -.09, p < .01
		Chile	Pop IV	Literature	+			r = .07, p < .01
		Iran	Pop II	Literature		0		r = .01, NS
		Iran	Pop IV	Literature			-	r = -.10, p < .01

ANNEX TABLE IV (continued, p. 3)

Independent Variable	Author(s)	Country	School Level[a]	Criterion Variable	Relationship +	0	-	Comments
2. Teacher Age								
	Farrell & Schiefelbein	Chile	P&S	Math & Verbal	+			β = .067, p < .01
	Fuller & Chantavanich	Thailand	P	Math & Thai		0		Slightly negative, but not significant; r = -.038 and -.036 with beginning and end of year scores.
	Husén	Botswana	P	Mathematics	+			F-value = 6.09, p < .01
				Reading	+			F-value = 7.85, p < .01
	Klees	Mexico	S			0		Figures not reported.
3. Teacher SES								
	Farrell & Schiefelbein[b]	Chile	P&S	Math & Verbal	+			β = .0386, p < .01
	Heyneman	Uganda	P	PLE exam[c]		0		r = -.14, NS. Data aggregated by school.
	Ryan	Iran	P	Math & Language	+			r = .19; β = .167

[b] Composite of father's education and occupation, mother's education, and teacher level of education.

[c] Primary Leaving Exam consists of equally-weighted sections of math, English, and general knowledge in science, history and geography.

Independent Variable	Author(s)	Country	School Level[a]	Criterion Variable	Relationship +	0	-	Comments
4. Frequency of English in Childhood Home								
	Heyneman	Uganda	P	PLE exam[c]		0		r = -.20, N.S. Data aggregated by school.
B. TEACHER QUALIFICATION VARIABLES								
5. Teacher Educational Attainment								
	Carnoy	Puerto Rico	P&S	Spanish Reading & Gen Ability	+(P)	0(S)		Ed attainment important for primary but not secondary grades. Also more impact on low SES students in P grades.
	Fuller & Chantavanich	Thailand	P	Math & Thai		0		r = .11 and .12, NS, for Ach at beginning and end of year scores.
	Heyneman	Uganda	P	PLE exam[b]		0		r = -.11, NS
	Husén	Botswana	P	Mathematics	+			Educational attainment important for Math Ach only.
				Reading		0		
	Izquierdo & Guzman	Mexico	P	Math & Lang		0		r = -.069, NS

Independent Variable	Author(s)	Country	School Level[a]	Criterion Variable	Relationship +	0	-	Comments
5. Teacher Educational Attainment (continued)								
	Levy	42 LDCs[d]	P	Dropout Rates		0		Data aggregated by country. Variable did not enter stepwise regression. No figures reported.
			IEA Between-Student Comparisons					
	Purves	Chile	Pop II	Literature	+			r = .34, p < .01
		Chile	Pop IV	Literature		0		r = .03, NS
		Iran	Pop II	Literature	+			r = .11, p < .01
6. Teacher Credentials and Certification (Level of Training)								
	Beebout	Malaysia	S	MC Exam[e]	+			r = .268 for total sample; b = .345 for Malay schools only.
	Bibby & Peil[f]	Ghana	S	GC Exams[g]	+			School-teacher effects more important than home effects: β^2 = .41, β^2 = .28 compared with .08 and .02.

[d] The countries include 15 from Latin America, 14 from Africa and Middle East, and 13 from Asia.

[e] Standardized achievement battery taken at completion of upper secondary school. Most important components for Malay Medium students were geography and Malay, for English Medium geography and science.

[f] Proxy variable only. Teacher qualifications inferred from school quality.

[g] Ordinary Level General Certificate of Education exam of 5th form students.

Independent Variable	Author(s)	Country	School Level[a]	Criterion Variable	Relationship +	0	-	Comments
6. Teacher Credentials (continued)								
	Carnoy	Puerto Rico	P&S	Spanish Reading & Gen. Ability	+(S)	0(P)		Qualifications affect Ach only at secondary level.
	Currie	Uganda	P	Examination Pass Level[h]	+			B = .31 and .17 for 1954 and 1964 graduates. The most important of the independent variables.
	Ellson	Malaysia	P	Malay Reading			-	t-test = 2.18, $p < .05$, between experimental (untrained teachers) and control (trained teachers) classes. Untrained teachers had greatest impact.
	Fuller & Chantavanich	Thailand	P	Mathematics & Thai	+			r = .159 and .093 for beginning and end of year scores; Beta = .068, $p < .01$, but adds little to variance explained.
	Heyneman	Uganda	P	PLE exam[b]		0		r = .09, NS.
	Husén	Botswana	P	Mathematics	+			Teacher training has an effect on Reading Ach but not Math Ach. However, between-school comparison show trained teachers more effective in both subjects.
				Reading		0		
	Klees[i]	Mexico	S	Mathematics & Language	+			Figures not reported.

[h] Exam Pass Level = 1st year pass, 2nd year pass, 3rd year pass & GCE, and Fail.

[i] Composite index including teacher educational attainment and level of training.

Independent Variable	Author(s)	Country	School Level[a]	Criterion Variable	Relationship +	0	-	Comments
6. Teacher Credentials (continued)								
	Silvey[f]	Uganda	S	SS Exams and CSC Exams[j]		0		Cross-tabs, no contro no qualification effe
	Somerset[f]	Uganda	S	CSC Exams[j]		0		Author suggests that school and teacher ef are more pronounced a primary level and are irreversible.
	Williams	Guatemala	P	Dropout Rates	+			The regions with more qualified teachers ha higher retention.
	Windham[j]	Sierra Leone	P	Occup. Aspiration		0		
	Youdi	Congo	S	Math & French	+			Teacher training the most important deter- minant of Ach. No figures reported.
		IEA Between-School Comparisons						
	Comber & Keeves	Chile	Pop IV	Science Ach		0		r = .08, NS
		India	Pop IV	Science Ach	+			r = .23, p < .01
		Iran	Pop IV	Science Ach		0		r = .16, NS
		IEA Between-Student Comparisons						
	Carroll	Chile	Pop IV	French Reading		0		t = NS
		Chile	Pop IV	French Listening			-	t = -2.41. No explanation given for the negative result.

[j] Secondary School Selection Exam and the Cambridge School Certificate Exam.

ANNEX TABLE IV (continued, p. 8)

Independent Variable	Author(s)	Country	School Level[a]	Criterion Variable	Relationship +	0	-	Comments
6. Teacher Credentials (continued)								
			IEA Between-Student Comparisons					
	Comber & Keeves	Chile	Pop IV	Science Ach	+			r = .15, p < .01
		India	Pop IV	Science Ach	+			r = .10, p < .01
		Iran	Pop IV	Science Ach	+			r = .09, p < .01
7. Teacher Ability and Achievement								
	Fuller & Chantavanich	Thailand	P	Math & Thai		0		r = .11 and .13, NS, for beginning and end of year achievement.
	Heyneman	Uganda	P	PL Exam[c]	+			r = .31, p < .01. The only one of six teacher variables with a significant relationship with achievement.
	Izquierdo & Guzman	Mexico	P	Math & Thai		0		r = .038, NS
	Ryan	Iran	P	Language & Math	+			r = .14. Teacher ability is more strongly related to achievement in the poorest region (β = .353).

Independent Variable	Author(s)	Country	School Level[a]	Criterion Variable	Relationship +	0	-	Comments
7. Teacher Ability (continued)								
	Schmelkes	Mexico	P	Arith., Geometry & Language		0		Figures not reported.
			IEA Between-Student Comparisons					
	Lewis & Massad	Chile	Pop IV	English Reading	+			r = .07, p < .01
		Chile	Pop IV	English Listening	+			r = .14, p < .01
		Thailand	Pop II	English Reading	+			r = .11, p < .01
		Thailand	Pop IV	English Reading			-	r = -.10, p < .01
8. Teacher Experience								
	Beebout	Malaysia	S	MC Exam[c]	+			r = .031 for total sample; r = .268 in interaction with qualifications. Regression coefficients (b) for Malay and English language schools are .407 and .219 respectively. As qualification increases, importance of experience decreases. More for Malay than English schools.
	Carnoy	Puerto Rico	P&S	Spanish Reading & Gen. Ability	+(P)		-(S)	Experience has positive effects and primary, but negative effects at secondary levels. More pronounced for reading Ach than Gen. ability.

Independent Variable	Author(s)	Country	School Level[a]	Criterion Variable	Relationship +	0	-	Comments
3. Teacher Experience (continued)								
	Heyneman	Uganda	P	PL Exam[c]		0		r = -.03, NS
	Husén	Botswana	P	Mathematics	+			Cross-tabs, F-value = 3.80, p < .01
				Reading Comp.	+			F-value = 4.13, p < .001
	Izquierdo & Guzman	Mexico	P	Math & Language	+			r = .11, p < .05
	Klees	Mexico	S	Math & Language			-	Figures not reported.
	Schmelkes	Mexico	P	Arith, Geometry & Language	+			Zero-order correlation NS. Figures not reported.
	Thias & Carnoy	Kenya	P	KPE[k]	+			"Seniority" in the equation makes difference between sig. and NS coefficients. Authors conclude that seniority is better predictor than qualifications. R^2 = .06.
				IEA Between-Student Comparisons				
	Carroll	Chile	Pop IV	French Reading		0		t = NS
		Chile	Pop IV	French Listening			-	t = -0.63

[k] KPE = Kenya Preliminary Exam, which is the leaving exam after seven years of primary schooling.

Independent Variable	Author(s)	Country	School Level[a]	Criterion Variable	Relationship +	0	-	Comments
9. Teacher Salary								
	Bibby & Peil[f]	Ghana	S	GC Exams[g]	+			School and teacher effects more important than home effects; β^2 = .41, β = .28 compared with .08 and .02 respectively.
	Levy	42 LDCs	P	Dropout rates		0		Data aggregated at country level. Teacher salaries were unrelated to dropout rates, but author claims evidence inconclusive.
	Thias & Carnoy	Kenya	P	KPE[l]	+			Average teacher salary has significant effect on exam score at primary level. R^2 = .006, B = .079, p < .05.
			S	HSC[l]				
10. Teacher Upgrading Programs								
	Husén	Botswana	P	Mathematics	+			The relationship is stronger for Reading Comp. than for Math.
				Reading Comp.	+			
	Nasoetion, et al.	Indonesia	P	Bahasa Indonesia	+			r = .146 between upgrading and post-test results; R^2 = .1219, increment due to upgrading = .0042, p < .05.

[l] KPE = Kenya Preliminary Exam (of footnote k); HSC = Higher School Certificate Exam, administered at end of Form VI.

Independent Variable	Author(s)	Country	School Level[a]	Criterion Variable	Relationship +	0	-	Comments
C. TEACHER BEHAVIOR AND ATTITUDES								
11. Teacher Expectations of Students								
	Durojaiye	Uganda	S	SAT[m]	+			r = .162, p < .05 for rural boys; r = .14, .113, and .146 (all NS) for rural girls and urban boys and girls respectively. SES of students was negatively related to performance.
	Fuller & Chantavanich	Thailand	P	Math & Thai	+			r = .217 and .228 for beginning and end of year performance. β = .101, was 5th most important determinant of Ach in stepwise regression.
	Philippines Dept. of Ed. & Culture	Philippines	P	General Academic Achievement[n]	+			Cross-tabs only. "As teacher's evaluation becomes more positive, the students' performance also increases above the levels of their own self-esteem."
	Rowe	Hong Kong	P	Academic Failure[o]	+			Experimental design, in-depth study of 100 failures and non-failures. Teacher expectations related to failure, more in Arithmetic than Chinese or English.

[m] Scholastic Aptitude Test. Components not specified.

[n] Performance in nine subject areas: Reading, Language, Math & Science. Scores were combined to form an average standardized score.

[o] Scores on Arithmetic, Chinese and English.

ANNEX TABLE IV (continued, p. 13)

Independent Variable	Author(s)	Country	School Level[a]	Criterion Variable	Relationship +	0	-	Comments
12. Teaching Method								
	Ellson	Malaysia	P	Malay Reading	+			t = 2.18, p < .05 between programmed and conventional teaching methods.
	Hornik	El Salvador	S	Cognitive Skills[P]	+			r = .07 and .52 for gains with and without ITV.
	Klees	Mexico	S	Math, Language & Chemistry	+			Students exposed to TV instruction showed higher gains than traditional instruction.
	Okunrotifa	Nigeria	S	Geography	+			Post-test of experimental and control groups show significant differences in favor of programmed instruction (p < .01), even with pre-test controlled.
13. Teacher Absenteeism and Punctuality								
	Fuller & Chantavanich	Thailand	P	Math & Thai		0		Contributed virtually nothing to variance explained in the national regression equation; β = .012, NS.
140	Izquierdo & Guzman	Mexico	P	Math & Lang		0		r = .077, NS 141

[P] General ability and reading tests, achievement in three subjects: math, social studies and science.

Independent Variable	Author(s)	Country	School Level[a]	Criterion Variable	Relationship +	0	−	Comments
14. Teacher Attitudes Toward Job and Career								
	Durojaiye	Uganda	S	SAT[m]	+			r = .253 and .212, p < .05, for urban male and female students. Results for rural students slightly positive but NS.
	Izquierdo & Guzman	Mexico	P	Math & Lang		0		r = −.002, NS
	Klees	Mexico	S	Math & Lang		0		Figures not reported.
	Ryan	Iran	P	Math & Lang	+			"Teacher Frankness" (proxy for sense of security) and rating of supervisor (proxy for career satisfaction) were related to Ach, more in rural and small schools than urban and large schools.
	Somerset	Uganda	S	CSC[j]		0		Increase in prediction was "infinitesimal." Multiple increased from .3804 to .3807.
15. Teaching Behavior:								
1) Homework Assignment								
IEA Between-Schools Comparison								
	Comber & Keeves	Chile	Pop II	Science Ach		0		r = .05, NS
		Chile	Pop IV	Science Ach		0		r = .14, NS

Independent Variable	Author(s)	Country	School Level[a]	Criterion Variable	Relationship +	0	-	Comments
15. Teaching Behavior (continued)								
	Comber & Keeves	India	Pop II	Science Ach	+			r = .31, p < .01
		India	Pop IV	Science Ach	+			
		Iran	Pop IV	Science Ach		0		r = .14, NS
			IEA Between-Student Comparisons					
	Comber & Keeves	Chile	Pop I	Science Ach		0		r = .04, NS
		Chile	Pop II	Science Ach		0		r = .02, NS
		Chile	Pop IV	Science Ach	+			r = .13, p < .01
		India	Pop I	Science Ach		0		r = .05, p < .01
		India	Pop II	Science Ach	+			r = .12, p < .01
		India	Pop IV	Science Ach	+			r = .31, p < .01
		Iran	Pop I	Science Ach		0		r = .02, NS
		Iran	Pop II	Science Ach	+			r = .12, p < .01
		Iran	Pop IV	Science Ach		0		r = .00, NS
		Thailand	Pop II	Science Ach	+			r = .24, p < .01

Independent Variable	Author(s)	Country	School Level[a]	Criterion Variable	Relationship +	0	-	Comments
15. Teaching Behavior (continued)								
11) Lesson Preparation								
			IEA Between-Student Comparisons					
	Comber & Keeves	Chile	Pop IV	Science Ach	+			r = .20, p < .01
	Lewis & Massad	Chile	Pop IV	English Reading	+			r = .16, p < .01
		Chile	Pop IV	English Listening			-	r = -.15, p < .01
		Thailand	Pop II	English Reading		0		r = .005, NS
		Thailand	Pop IV	English Reading	+			r = .27, p < .01
16. School-Teacher Block Variables (IEA Studies)[9]								
			IEA Between-School Comparisons					
	Comber & Keeves	Chile	Pop I	Science Ach	+			36% of variance explained by School-Teacher Block, compared to 3% by Background Block.
		Chile	Pop II	Science Ach		0		15% of variance explained by School-Teacher Block, compared to 19% by Background Block.
		Chile	Pop IV	Science Ach		0		12% of variance explained by School-Teacher Block, compared to 64% by Background Block.

[9] For all IEA studies, Pop I = 10 yr old pupils, Pop II = 14 yr old, and Pop IV = final year of secondary school. As a rule, Block I contained home background variables, plus student sex and age (in months). The School-Teacher Block (in most instances, Block 3) contained variables related to learning conditions in the school, including teacher characteristics and teaching methods. However, the stepwise regression techniques allowed only those variables to enter the equation which met specific criteria, thus the block for each equation may be varied with respect to its components.

Independent Variable	Author(s)	Country	School Level[a]	Criterion Variable	Relationship +	0	−	Comments
16. School-Teacher IEA Block (continued):				IEA Between-School Comparisons				
	Comber & Keeves	India	Pop I	Science Ach	+			28% of variance explained by School-Teacher Block, compared to 2% by Background Block.
		India	Pop II	Science Ach	+			21% of variance explained by School-Teacher Block, compared to 5% by Background Block.
		India	Pop IV	Science Ach	+			45% of variance explained by School-Teacher Block, compared to 5% for Background Block.
		Iran	Pop I	Science Ach		0		13% of variance explained by School-Teacher Block, compared to 29% by Background Block.
		Iran	Pop IV	Science Ach		0		8% of variance explained by School-Teacher Block, compared to 32% by Background Block.
	Purves	Chile	Pop II	Literature Ach		0		9.5% of variance explained by School-Teacher Block, compared to 36.2% by Background Block.
		Chile	Pop IV	Literature Ach		0		9.6% of variance explained by School-Teacher Block, compared to 45.3% by Background Block.
		Iran	Pop IV	Literature Ach		0		15.2% of variance explained by School-Teacher Block, compared to 38.7% by Background Block.

Independent Variable	Author(s)	Country	School Level[a]	Criterion Variable	Relationship +	0	-	Comments
16. School-Teacher IEA Block (continued):				IEA Between-School Comparisons				
	Thorndike	Chile	Pop I	Reading	+			28% of variance explained by School-Teacher Block; no comparison with Background Block possible.[r]
		Chile	Pop II	Reading		0		2% of variance explained by School-Teacher Block.
		Chile	Pop IV	Reading		0		3% of variance explained by School-Teacher Block.
		India	Pop I	Reading	+			19% of variance explained by School-Teacher Block.
		India	Pop II	Reading	+			11% of variance explained by School-Teacher Block.
		India	Pop IV	Reading	+			11% of variance explained by School-Teacher Block.
		Iran	Pop I	Reading	+			37% of variance explained by School-Teacher Block.
		Iran	Pop IV	Reading	+			33% of variance explained by School-Teacher Block.
				IEA Between-Student Comparisons				
	Carroll	Chile	Pop IV	French Reading	+			7.2% of variance explained by School-Teacher Block, compared to 1.4% by Background Block.

[r] Thorndike combines results from Blocks I (Background) and Block II (School Type), making comparisons between Background and School-Teacher Blocks impossible. However, he does not follow this procedure for Between-Student comparisons.

ANNEX TABLE IV (continued, p. 19)

Independent Variable	Author(s)	Country	School Level[a]	Criterion Variable	Relationship +	0	-	Comments
16. School-Teacher IEA Block (continued):								
				IEA Between-Student Comparisons				
	Carroll	Chile	Pop IV	French Listening	+			32.5% of variance explained by School-Teacher Block, compared to 14.6% by Background Block.
	Comber & Keeves	Chile	Pop I	Science Ach	+			9% of variance explained by School-Teacher Block, compared to 4% by Background Block.
		Chile	Pop II	Science Ach		0		6% of variance explained by School-Teacher Block, compared to 13% by Background Block.
		Chile	Pop IV	Science Ach		0		8% of variance explained by School-Teacher Block, compared to 19% by Background Block.
		India	Pop I	Science Ach	+			20% of variance explained by School-Teacher Block, compared to 1% by Background Block.
		India	Pop II	Science Ach	+			8% of variance explained by School-Teacher Block, compared to 3% by Background Block.
		India	Pop IV	Science Ach	+			17% of variance explained by School-Teacher Block, compared to 4% by Background Block.

Independent Variable	Author(s)	Country	School Level	Criterion Variable	Relationship +	0	-	Comments
16. School-Teacher IEA Block (continued):				IEA Between-Student Comparisons				
	Comber & Keeves	Iran	Pop I	Science Ach	+			6% of variance explained by School-Teacher Block, compared to 6% by Background Block.
		Iran	Pop II	Science Ach	+			9% of variance explained by School-Teacher Block, compared to 5% by Background Block.
		Iran	Pop IV	Science Ach	+			4% of variance explained by School-Teacher Block, compared to 3% by Background Block.
		Thailand	Pop II	Science Ach	+			23% of variance explained by School-Teacher Block, compared to 10% by Background Block.
	Lewis & Massad	Chile	Pop IV	English Reading	+			15.2% of variance explained by School-Teacher Block, compared to 8.2% by Background Block.
		Chile	Pop IV	English Listening	+			33.3% of variance explained by School-Teacher Block, compared to 3.2% by Background Block.
		Thailand	Pop II	English Reading	+			9.9% of variance explained by School-Teacher Block, compared to 8.2% by Background Block.
		Thailand	Pop IV	English Reading	+			17.1% of variance explained by School-Teacher Block, compared to 12.8% by Background Block.

Independent Variable	Author(s)	Country	School Level	Criterion Variable	Relationship +	0	−	Comments
16. School-Teacher IEA Block (continued):				IEA Between-Student Comparisons				
	Purves	Chile	Pop II	Literature Ach		0		8.9% of variance explained by School-Teacher Block, compared to 14.4% by Background Block.
		Chile	Pop IV	Literature Ach		0		5.7% of variance explained by School-Teacher Block, compared to 10.5% by Background Block.
		Iran	Pop II	Literature Ach	+			12.1% of variance explained by School-Teacher Block, compared to 4.5% by Background Block.
		Iran	Pop IV	Literature Ach		0		5.7% of variance explained by School-Teacher Block, compared to 8.3% by Background Block.
	Thorndike	Chile	Pop I	Reading	+			8.3% of variance explained by School-Teacher Block, compared to 1.4% by Background Block.
		Chile	Pop II	Reading		0		6.6% of variance explained by School-Teacher Block, compared to 20.1% by Background Block.
		Chile	Pop IV	Reading		0		5.1% of variance explained by School-Teacher Block, compared to 14.9% by Background Block.
		India	Pop I	Reading	+			14.9% of variance explained by School-Teacher Block, compared to 1.6% by Background Block.

Independent Variable	Author(s)	Country	School Level	Criterion Variable	Relationship +	0	-	Comments
16. School-Teacher IEA Block (continued):				IEA Between-Student Comparisons				
	Thorndike	India	Pop II	Reading	+			9.7% of variance explained by School-Teacher Block, compared to 6.1% by Background Block.
		India	Pop IV	Reading	+			4.7% of variance explained by School-Teacher Block, compared to 4% by Background Block.
		Iran	Pop I	Reading		0		7.2% of variance explained by School-Teacher Block, compared to 8.7% by Background Block.
		Iran	Pop II	Reading	+			6.6% of variance explained by School-Teacher Block, compared to 6.1% by Background Block.
		Iran	Pop IV	Reading	+			7.6% of variance explained by School-Teacher Block, compared to 5.5% by Background Block.
				Between-School Comparisons				
	Shukla[8]	India	Pop I	Science Ach	+			28% of variance explained by School-Teacher Block, compared to 13.1% ave. for developed countries.
		India	Pop I	Reading	+			19% of variance explained by School-Teacher Block, compared to 14.1% ave. for developed countries.

[8] Shukla reinterprets the Indian IEA data from Comber & Keeves and Thorndike, by comparing the variance explained by each Block with the average for the developed countries.

Independent Variable	Author(s)	Country	School Level[a]	Criterion Variable	Relationship +	0	-	Comments
16. School-Teacher IEA Block (continued):				IEA Between-School Comparisons				
	Shukla	India	Pop II	Science Ach	+			20.8% of variance explained by School-Teacher Block, compared to 10.9% ave. for developed countries.
		India	Pop II	Reading	+			11.4% of variance explained by School-Teacher Block, compared to 3.4% ave. for developed countries.
		India	Pop IV	Science Ach	+			44.8% of variance explained by School-Teacher Block, compared to 15.6% ave. for developed countries.
		India	Pop IV	Reading		0		11.4% of variance explained by School-Teacher Block, compared to 11.6% ave. for developed countries.
				IEA Between-Student Comparisons				
		India	Pop I	Science Ach	+			19.8% of variance explained by School-Teacher Block, compared to 6.7% ave. for developed countries.
		India	Pop I	Reading	+			14.9% of variance explained by School-Teacher Block, compared to 3.9% ave. for developed countries.

ANNEX TABLE IV (continued, p. 24)

Independent Variable	Author(s)	Country	School Level[a]	Criterion Variable	Relationship +	0	-	Comments
16. School-Teacher IEA Block (continued):				IEA Between-Student Comparisons				
	Shukla	India	Pop II	Science Ach		0		8.1% of variance explained by School-Teacher Block, compared to 8.4% ave. for developed countries.
		India	Pop II	Reading	+			9.7% of variance explained by School-Teacher Block, compared to 4.3% ave. for developed countries.
		India	Pop IV	Science Ach	+			17.1% of variance explained by School-Teacher Block, compared to 15.7% ave. for developed countries.
		India	Pop IV	Reading	+			4.7% of variance explained by School-Teacher Block, compared to 4.6% ave. for developed countries.

ANNEX TABLE V

SUMMARY OF RELATIONSHIPS FOR EACH TEACHER AVAILABLE

		Direction of Relationship +	0	-
I. DEMOGRAPHIC AND BACKGROUND VARIABLES				
1. Teacher Sex (M=1, F=2)	Regular studies	2	1	2
	IEA studies	7	5	10
2. Teacher Age		3	2	-
3. Teacher SES		2	1	-
4. Frequency of English in Childhood Home		-	1	-
II. TEACHER QUALIFICATION VARIABLES				
5. Teacher Educational Attainment	Regular studies	2	6	-
	IEA studies	2	1	-
6. Teacher Credentials and Certification	Regular studies	9	6	1
	IEA studies	4	3	1
7. Teacher Ability and Achievement	Regular studies	2	3	-
	IEA studies	3	-	1
8. Teacher Experience	Regular studies	7	1	2
	IEA studies	-	1	1
9. Teacher Salary		3	1	-
10. Teacher Upgrading		3	-	-
III. TEACHER BEHAVIOR AND ATTITUDES				
11. Teacher Expectations of Students		4	-	-
12. Teaching Methods (ITV, programmed instruction, etc.)		4	-	-
13. Teacher Absenteeism and Punctuality		-	2	-
14. Teacher Attitude Toward Job		2	3	-
15. Teacher Behavior: Homework Assignment		7	8	-
Lesson Preparation		3	1	1
16. IEA School-Teacher Block Analyses:	Science	17	7	
	Literature	1	6	
	Reading	17	6	
	French	2	-	
	English as Foreign Language	4	-	

ANNEX TABLE VI

SAMPLE AND LEVEL OF ANALYSIS FOR TEACHER STUDIES (p. 1)

Author(s)	Country	Sample		Level of Analysis
		Primary	Secondary	
Beebout (1972)	Malaysia		7,674 students in grades 10 and 11 in 89 schools, stratified by state and language. Data from exam records and headmaster questionnaires.	Between-student with teacher and community data aggregated by school.
Bibby & Peil (1974)	Ghana		585 students in 5th Form from 11 schools.	Between-student
Carnoy (1971)	Puerto Rico	1967 School Survey data, N=182,000 male students from grades 3, 6, 9, and 12. Teacher and school data taken from school records.		Between-student with teacher and school data aggregated at school level.
Carroll (IEA, 1975)	Chile		Pop IV, final year in high school. 60 schools and 1529 students.	Between-student and between-school with aggregated teacher data.
Comber & Keeves (IEA, 1973)	Chile India Iran Thailand	Chile: Pop I: 81 schools and 1470 students. Pop II: 103 schools and 1311 students. Pop IV: 73 schools and 2052 students. India: Pop I: 176 schools and 2704 students. Pop II: 155 schools and 2931 students. Pop IV: 124 schools and 3153 students. Iran: Pop I: 53 schools and 1640 students. Pop II: 33 schools and 1336 students. Pop IV: 34 schools and 1435 students. Thailand: Pop I: 31 schools and 1810 students. Pop II: 29 schools and 1932 students. Pop IV: 13 schools and 724 students.		Between-student and Between-school with aggregated teacher data.

ANNEX TABLE VI (continued, p. 2)

Author(s)	Country	Sample		Level of Analysis
		Primary	Secondary	
Currie (1977)	Uganda		Questionnaires to all school graduates of 1954, 1959, 1964, and 1969. 41% response rate; male sample = 463.	Between-student with teacher proxy by quality of school variable.
Durojaiye (1973)	Uganda		540 students from Standards I, II, and III in rural and urban secondary schools.	Between-student
Ellson (1973)	Malaysia	10 each of the highest and lowest students from 10 schools for control and experimental groups (N for each group = 98). 10 each of trained and untrained teachers; one teacher per 10 students.		Between-student
Farrell & Schiefelbein (1974)	Chile	10 students and 7 teachers from grade 8 classes (in both primary and secondary schools); N for classes = 353.		Between-student; teacher data aggregated for each class.
Fuller & Chantavanich (1976)	Thailand	Stratified random sample of 23,555 grade 3 students and 987 teachers.		Between-student; aggregated teacher data by school.
Heyneman (1976 a, b, c)	Uganda	67 primary schools in 5 regions, 2,293 grade 7 pupils and 598 teachers.		Between-school

ANNEX TABLE VI (continued, p. 3)

Author(s)	Country	Sample: Primary	Sample: Secondary	Level of Analysis
Hornik (1973, (1975)	El Salvador		26 classes who began 7th grade in 1970 and 9th in 1972; 15 classes used ITV (student N not reported).	Between-class
Husén (1977)	Botswana		Two-stage stratified random sample of 37 primary schools, 869 Standard 7 students, 562 teachers.	Between-student with individual teacher data linked with student.
Izquierdo & Guzman (1971)	Mexico	519 students in grades 3, 4, and 5; 60 teachers.		Between-student; not clear on teacher data.
Klees (1974)	Mexico		1236 students in 58 classes with Telesecundaria; 1101 students in 23 classes without.	Between-student with teacher data aggregate by class.
Lewis & Massad (IEA, 1975)	Chile Thailand	Thailand: Pop II: 40 schools and 1957 students. Pop IV: 15 schools and 936 students. Chile: Pop IV: 80 schools and 2314 students.		Between-student
Levy (1971)	42 LDCs	Published and unpublished government and international agency reports on retention rates for primary school. No figures reported.		Between-country

ANNEX TABLE VI (continued, p. 4)

Author(s)	Country	Sample		Level of Analysis
		Primary	Secondary	
Nasoetion, et al. (1976)	Indonesia	Experimental and control grade 5 classes for new and old textbook and with and without upgraded teachers (8 classes in each cell); schools chosen randomly.		Between-student
Okunrotifa (1975)	Nigeria	Experimental and control grade 8 classes.		Between-class
Philippines Dept. of Educ. & Culture (1976)	Philippines	Stratified random sample of 586 schools, with 28,915 6th grade pupils, and 2,930 5th grade pupils. Teacher N = 5,123.		Between-student with teacher class data linked with indiv. student.
Purves (IEA, 1973)	Same as for Comber & Keeves			
Rowe (1966)	Hong Kong	The lowest 20 Primary IV students from 5 schools (N = 100) and top 10 students from same schools.		Between-student
Ryan (1974)	Iran	66 schools and 797 grade 2 students, 66 teachers, in 3 governorships.		Between-student

ANNEX TABLE VI (continued, p. 5)

Author(s)	Country	Sample		Level of Analysis
		Primary	Secondary	
Schmelkes (1972)	Mexico	Representative stratified sample of 24 schools and 161 students from grades 1-4.		Between-grade
Shukla (1974)	India	Secondary analysis of data reported by Comber & Keeves and Thorndike; Pop I, II, and IV for Science and Reading IEA.		Between-student and between-school
Silvey (1972)	Uganda		211 final year secondary students for whom both junior exam and final year exam scores were available.	Between-student
Somerset (1968)	Uganda		All 1964 candidates for the CSC who sat Junior Secondary Leaving Exams. Student N = 881.	Between-student
Thias & Carnoy (1972)	Kenya	Random sample of 89 rural schools, Student N = 3,405 from grade 7 who had taken the Kenya Preliminary Exam.		Between-school
			All students who took the Cambridge School Certificate exam (after Form IV, i.e., grade 11) in 115 rural and urban schools.	Between-school

ANNEX TABLE VI (continued, p. 6)

Author(s)	Country	Sample		Level of Analysis
		Primary	Secondary	
Thorndike (IEA, 1973)	Chile India Iran	Same as for Comber & Keeves		
Williams (1965)	Guatemala	Official retention records for all students in primary grades 1-3.		Between-student and between-region
Windham (1970)	Sierra Leone		116 students from Forms 3 and 5 in a government and a missionary school.	Between-school
Youdi (1970)	Congo		1450 students from Forms 5 and 6 in 25 schools.	Between-student with aggregated teacher and school variables.

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